RAILWAY
MECHANICAL ENGINEER

Full Program of Reports Presented at Business Meeting of the Master

Boiler Makers' Association

Carl Harper,
Vice-President

W. N. Moore, President

A. F. Stiglmeier,
Secretary-Treasurer

THE twenty-fifth annual meeting of the Master Boiler Makers' Association was held at the Hotel Sherman, Chicago, September 26 and 27, the first day being devoted to an executive committee meeting, while the second was devoted to the presentation of seven topics, abstracts of which are herein included. Although the meeting was called for committee members only, 56 railroad members and guests were registered at the Tuesday session.

A committee report was presented on topics selected for the 1939 meeting, a change in the scope of which is intended to increase the service rendered by the association to the railroads. Among the new topics selected for presentation at the 1939 meeting will include (1) recommended practices to railroad management on the training of boiler-maker apprentices, (2) the standardization of inspection, testing and cleaning of air reservoirs, (3) the renewal of fireboxes, including laying out, fabrication and application, as well as the application of crown and staybolts, (4) a standard practice for locating the height of crown sheet, water glass, gage cocks and low-water-alarm drop pipe, and also recommended practices for marking the back head for water level and the highest point of the crown sheet, (5) the advantages and disadvantages of using all-welded and alloy steel for locomotive cisterns to decrease weight and to reduce pitting and corrosion, and (6) the causes of flues in service cracking longitudinally through the bead and means for eliminating such cracking.

Improving boiler circulation, honeycombing and slagging, proper waste-bear designs, pitting and corrosion, cinder cutting, and the proper method of applying flexible staybolts are among the subjects discussed

Because this year's session constituted a business meeting only, it was decided that the officers elected in 1937 should direct the association's activities during the coming year. These are as follows: President, W. N. Moore, general boiler foreman, Pere Marquette, Grand Rapids, Mich.; vice-president and chairman of the executive board, Carl Harper, general boiler inspector, Cleveland, C. C. & St. L., Indianapolis, Ind.; secretary-treasurer, A. F. Stiglmeier, general foreman boiler department, New York Central, West Albany, N. Y. M. C. France, general boiler inspector, C. St. P. M. & O., St. Paul, Minn.; L. W. Steeves, boiler foreman, C. & E. I., Danville, Ill.; and C. W. Buffington, master boiler maker, C. & O., Huntington, W. Va., were elected in 1937 to three-year terms on the executive board and

L. R. Haase, district boiler inspector, B. & O., Swissvale, Pa., will continue to serve out the unexpired term on the executive board of W. N. Moore, who was elected president of the association.

Secretary Stiglmeier, reporting on the financial status of the association, announced that the executive committee had decided that membership dues would be waived for the year 1939-1940.

Suggestions for Reducing Leaky Stays and Cracked Side Sheets

Improved boiler circulation, proper washing of boilers, water treatment, and standard methods of changing water aid in boiler maintenance

Chairman C. W. Buffington (C. & O.) reported on Topic No. 1: "What means can or have been suggested to improve circulatory and other conditions in the locomotive boiler to eliminate leaky stays and cracked side sheets?" He stated that standard practice for boiler washing, blowing down of boilers, filling up of boilers and firing up, together with the treatment of boiler feedwater, have aided materially in great improvements during the past 13 years in reducing the number of leaky staybolts and cracked side sheets on the C. & O. The chairman presented each of his committee members in turn, who read individual reports as follow:

Report by D. A. Stark

The following have resulted in improved boiler conditions on the Lehigh Valley: (1) The careful washing of boilers, (2) the careful blowing down and filling up of boilers and (3) the use of treated feedwater. Prior to the use of the latter, it was necessary on the Lehigh Valley to renew side sheet on an average of 15 to 18 months, while at the present time we are averaging 6 years. There have been also experiments of different methods of application of staybolts which, by increasing the water space and increasing the width of the mud ring, have resulted in better circulation; I believe is a big factor in the solution of this trouble.

Report by J. F. Powers

The Master Boiler Makers' Association's report for 1935 included a number of special papers, among which was Topic No. 3 entitled: "Staybolt Leakage and Cracking of Firebox Sheets—What Can Be Done to Prevent Same?" This included a complete report on the design of standard side sheets with corrugations. This design of side sheet has been used for the past 30 years by the Chicago & North Western, and with them we have experienced very little trouble with leaky staybolts.

It is generally accepted that adding heating surface and circulation to the conventional type of locomotive firebox and combustion chamber increases the efficiency of the locomotive; therefore, any type of circulator which is properly designed and can be maintained without interrupting the availability of the locomotive and with reasonable amount of expense is an asset to the locomotive.

Well-designed circulating devices are becoming an important factor, if not a necessity, due to the increasing horsepower of the modern steam locomotive and capacity from the boiler. Adding properly designed circulators to the firebox and combustion chamber in the opinion of the committee relieves the balance of the firebox of some of the work it would otherwise be required to do, particularly the side sheets where the temperature is high under the brick arch; this should help to eliminate leaky staybolts and prolong the life of the side sheets.

Report by W. R. Hedeman

Various means have been suggested for improving boiler-water circulation and a few have been tried out in service. One of the earliest means of major impor-

tance was the arch tube, though their application was primarily made for supporting the arch brick. However, these tubes do provide a definite circulation from the throat sheet to the upper portion of the back head. This has been conclusively proven by tests, showing that in arch tube locomotives the water surges higher at the back head than the normal water level, this surging being due to the rapid movement of the water through the arch tubes.

Various other methods have been tried out, some of which are still in use, one being the semi-water-tube firebox, having water troughs in the crown sheet connected to the side water legs by means of circulating tubes. This design has the effect of providing rapid circulation of the water from the bottom of the side water leg up along the side sheets to the tubes, and through them to the troughs, thence to the steam disengaging surface. Another type of circulator is the syphon, a great many of which are in service, and still another is the design of circulators consisting of several vertical water legs dropped from the crown sheet with transverse connections to each side water leg.

Since this subject deals principally with prevention of leaky staybolts and cracked side sheets, a design of firebox not possessing either one of these features, that is the staybolts or side sheets, would eliminate this trouble, and there are a number of such fireboxes in practical and successful service today.

We have on the Baltimore & Ohio, 12 locomotives with water-tube firebox boilers, the first built in 1927 and the last a four-cylinder type built in 1937, the total mileage to date of these locomotives being nearly 4,000,000 miles.

This design consists of a horizontal longitudinal drum at the top of the firebox, having rectangular shaped side headers connected thereto by means of 4-in. diameter nipples. These top headers in turn are connected to longitudinal lower side headers, flush with the grate surface, by means of double and triple rows of vertical water tubes which comprise the sides of the firebox, so far as the heating surface is concerned. These tubes are practically vertical and it is generally recognized that a tube of this type provides the best means of circulation.

Aside from the elimination of troublesome maintenance problems, improved circulation is highly desirable as a means of providing more efficient and economical production of steam.

All the water should circulate in one continuous current in a constant direction in order to carry off the steam quickly and to insure that the generating tubes contain as little steam and as much water as possible, which is essential to evaporative economy. The generating tubes should be arranged to facilitate free escape of the steam. When steam is generated in tubes, the steam bubbles rise most freely when the tubes are vertical and least freely when they are horizontal.

It has long been recognized that improved circulation is the purpose of water-tube boilers and experiments have demonstrated that the nearer vertical and straight the tubes stood in the boiler the more perfect the circulation, the freer it is from scale and steam pockets.

Report by C. A. Seley

The fundamental cause of leaking staybolts, cracked side sheets, and pitting and corrosion is mainly due to temperature differences in the various parts of the boiler, wherein the fire is at the back end and the feedwater is introduced at or near the front end; with a common temperature of the upper portion of the whole length of the steam space.

The obvious remedy for these troubles is to reduce the temperature range in the water leg by (1) preheating to the highest possible degree before admission to the boiler, and (2) promoting circulation of the introduced feedwater, which, due to its gravity, quickly seeks the lower portion of the boiler shell.

Remedy No. 1, preheating before admission cannot be done on a locomotive with any great degree of uniformity or in amount of heat transfer, as is possible in much of stationary power practice, due to the varying service of the locomotive, and use of the exhaust in the draft promotion.

The boiler water, therefore, is quite generally introduced into the boiler at temperatures around 200 deg., more or less, lower than the steam temperature. If considerably jetted it may pick up considerable heat in seeking the shell bottom and in its backward travel to the lower temperature level in the firebox throat and sides.

The general water circulation, due to the accretion of heat and the transfer into steam, draws the water from these lower regions, forces it upward at the side sheets and then forward over the crown sheet toward the flues, thereby maintaining the proper water level throughout the boiler. Thus, the bare locomotive boiler, regardless of size, provides for some self-generated circulation.

In order to increase that circulation, it would be necessary to introduce a device embodying a connection to the lower part of the boiler and extend it into the firebox, thereby creating additional heating surface and steam production, discharging into the upper region around or over the firebox, thereby greatly increasing the general circulation and minimizing the range of water temperature within the boiler.

With the growth in size of fireboxes came the necessity for directing hot gases to fill and heat the upper back corners, which brought about the use of arches and arch tubes. The latter, while primarily used as a support of the arch, incidentally aid the water circulation by drawing solid water from the throat sheet space, imparting heat during its backward travel, so that the discharge is mixed water and steam. These excellent results however are so in quality, but not in quantity, because the total heating surface added thereby is relatively small and the amount of water thus handled is proportional thereto. The Nicholson thermic syphon was devised and is in general use to compensate for these shortcomings, and also to provide a firm, adequate support for any desired brick arch. The value of Thermic-syphon circulation and increase of firebox heating surface has been demonstrated by its general use in America and abroad. The benefits derived in reduced staybolt breakage, as well as lengthened firebox and flue life were fully reported by a committee for the Master Boiler Makers' proceedings of 1931. With many designs of locomotive boilers, the back pair of drivers interferes with the application of lagging or cover for the wrapper sheet, and with a desire to promote the circulation at the sides of the firebox, a design of Thermic syphon has now been in service long enough to quite fully demonstrate a further improvement in the circulation.

Report by H. E. May

It is being brought to my attention through different channels that a great deal of trouble is being experienced on some other roads with side sheets checking, excessive staybolt breakage, etc. In my opinion, these troubles are due to improper maintenance, due in most instances, to failure of supervisory forces to give enough of their attention to those assigned to washing, blowing down

and filling boilers. I have found that this causes more fire checks in fireboxes than any other one thing. A second contributing factor is permitting scale clusters to build up around staybolts, causing the sheet to become unduly hot, the excessive amount of expansion and contraction resulting in cracking of sheets around staybolts.

The proper treating of water will eliminate the trouble with scale, but it will not prevent cracks in side sheets unless the washing and filling of boilers is done in the proper manner. I am confident that the standard practice for blowing down, washing and filling of boilers in force on the Illinois Central has increased our firebox life to such an extent that at the present time there is no way whereby we can anticipate just how long our fireboxes will last, and have reduced our staybolt breakage from an average of around five bolts per locomotive per month to one-sixth of one bolt per locomotive per month. Such performance as this certainly proves that it is up to the shop boiler force to maintain boilers, instead of expecting the chemist to do the whole job with feedwater treatment. They both go hand in hand, but one without the other is a waste of time and money.

I would also set forth the experience we have had with the American Arch Company's Security Circulators. We made our first application of these circulators to a Mountain-type locomotive, No. 2429, in August, 1934, which locomotive had last received a firebox in July, 1930, application being made to sheets which had already rendered four years' service. The results obtained caused us to apply three more sets: One set to locomotive No. 1143, in July, 1935, which received new side sheets in June, 1931; one set to locomotive No. 1053, in June, 1936, which last received a firebox in February, 1927; and one set to locomotive No. 1050, during September, 1936, which had received a firebox in June, 1934. Since the application of the circulators, these locomotives have made mileage as shown below:

Loco. No.	Mileage as of June 30, 1938
2429	220,040
1143	198,596
1053	118,974
1050	103,335

We have had no trouble with leaks, mud burns, blisters, etc., in these boilers since the circulators were applied and the conditions of sheets today is practically the same as when they were installed. In addition to this performance as to mileage and freedom from trouble with leaks, etc., these circulators, because of their design, have effected a considerable saving in the use of arch brick as compared with other locomotives of the same type in similar service.

Further I have been informed there are now 66 circulators installed in 15 locomotives operating on eight roads in the United States and Canada. These locomotives collectively have over a million locomotive miles to their credit since Security Circulators were installed in the first locomotive four years ago last July.

In not a single instance have the circulator units themselves required any maintenance, nor have they shown any signs of deterioration. There have been a few cases where joint welds at the side sheets have required attention, due to improper welding at installation, but these have not been serious and in no way have these leaks been considered a hazard.

While there have been no boiler-efficiency tests run on these circulator-equipped locomotives, day in and day out, operation points toward superior performance.

Another advantage brought out in service is more freedom from honeycombing and flue plugging. This, of course, must be due to the arch arrangement. A better proportioned arch is used and the baffle effect of the cross arms, which are exposed below the lower surface of the arch, probably has some effect in preventing some of the carry-over of partially consumed small particles of coal.

Results obtained to date indicate that firebox maintenance will be materially lowered. The first locomotive equipped four years ago carried its side sheets three years beyond what the renewal date would have been, adding about 200,000 miles to the life of these sheets.

The fourth locomotive to be equipped has been operating in the worst water country that could be found. In that territory, the life of arch tubes, syphons and side sheets is particularly short. This locomotive now has 30 months to its credit with a perfect record on firebox maintenance. Not only have the circulators been entirely trouble-free, but side sheets are reported to be as smooth and free from wrinkles and cracks as they were the day the locomotive was turned out with new side sheets and circulators. This cannot be said of any locomotives of the same class with comparable mileage. Present indications are that the side sheet life of this locomotive will be at least doubled.

The Proper Application of Flexible Staybolts

A discussion of two methods which have been used extensively for applying flexible staybolts

The committee members submitted individual reports on the following two questions: (A) Should flexible staybolts be set to a decided seat in the sleeves, cut to length and headed over on the firebox end? (B) should flexible staybolts be set to a decided seat in the sleeves and turned back one-quarter of a turn before cutting to length for heading? The committee suggested that the Master Boiler Makers' Association adopt method (A) as recommended standard practice; the reasons for this recommendation are set forth in the conclusion to this report.

Report by A. D. O'Neil

Although opinions differ concerning the most satisfactory method of applying flexible staybolts, my own experience generally favors the following method:

When applying flexible staybolts, subject each bolt to a preliminary seating, after which it should be slackened back one-half turn before being headed over and seated permanently. Firebox sheets are straightened and tack bolts applied to hold the sheets in alignment and insure proper water space. The balance of the holes are then tapped and the remaining bolts applied as outlined. Following application, the bolts should be cut off and headed over before tack bolts are disturbed, as all tack bolts will require resetting.

The practice of slackening each bolt one-half turn following preliminary seating is recommended to provide

uniformity of tension on each and every bolt involved. Obviously there are zones where one-half turn will prove insufficient and where it will be necessary to slack bolts back a greater distance. Bolts in syphon diaphragm plates adjacent to syphon necks are an illustration.

The development of flexible staybolts and their application to modern power represents one of the major advances in locomotive boiler progress. As such they should receive the utmost care in their application and maintenance. The methods for so doing as here set forth are based on many years of successful performance and hence recommended in lieu of alternate methods.

Report by F. Yochem

The practice on the Missouri Pacific is to apply flexible staybolts and radial stays to fireboxes and snub them in the sleeve after which they are cut off to length and driven. We do not deem it necessary or a good practice to slack the bolt off one-quarter of a turn after it has been seated in the sleeve since, in our opinion, slacking the bolt adds additional stress and strain in rigid staybolts or radial stays in that vicinity of firebox.

We realize on firebox renewal some of the holes in the new firebox sheets are not exactly in the same location as the original or first application, therefore, flexible bolt heads do not seat as freely in the sleeve as the original bolt did; therefore, we question the advisability of providing additional slack.

Report by E. J. Brennan

At the time flexible staybolts were adopted, it was the general practice to apply bolts turned back one-quarter to one-half turn. This was the method we used for a number of years with good results.

On boilers with full installation of flexible staybolts that had flush sleeves behind the cab, running board brackets and other fixtures, we encountered considerable trouble and expense in removing flush caps. After the third or fourth flexible staybolt test, the flush sleeves were so badly distorted that in most cases it was necessary to renew the sleeve, bolt and cap. We decided to eliminate the flush sleeves and apply hollow rigid staybolts. This was tried out on a few locomotives and after four years service the results obtained were satisfactory. As locomotives were shopped for heavy repairs, hollow rigid staybolts replaced flush flexible staybolts.

When we started applying hollow rigid bolts, the practice of applying flexible bolts was changed in order not to overload or stress the rigid staybolts. With the exception of flexible staybolts on the throat sheet around the syphon neck, all the rest are turned in to a decided seat in the sleeve. Over a period of ten years, on a check of 1,200 locomotives that have a full installation of flexible staybolts, we have not averaged over one broken bolt to a flexible bolt test. This is just as good, if not better than the record we had for the previous method for applying flexible bolts.

Staybolts are run in with a motor almost to a seat, then turned in the rest of the way by hand. The reason for finishing the application by hand is to take special care and know that the bolt is not bearing too hard in the sleeve, especially where the sleeves are old and have a tendency to be brittle, the vibrating or hammering caused by driving the bolt might possibly crack the sleeves if the staybolt were screwed in too tight.

Report by F. A. Longo

We must remember that the stresses on a flexible bolt are bending movements due to the unequal thermal expansion of inner and outer plates and vibration due to inequalities of track and speed of the locomotive. Added to these stresses is the tension of 7,500 lb. per sq. in. of cross-sectional area due to boiler pressure. This tensional stress is the only stress on a staybolt that can be accurately calculated.

The difference in temperatures between the inner and outer plates is governed by the firebox temperature, the amount of boiler scale adhering to the plates and by the speed of circulation of the water in contact with the plates. In addition we have vibratory stresses due to piston thrust and also drawbar shocks in the sudden starting and stopping of trains.

The types and classes of failure of staybolts is divided into two main divisions: First, broken or fractured bolts, and, second, failure of the joint between the bolt and the plate, causing leakage.

The broken bolts can be divided into two classes, the first of which is the slower or progressive crack type of fracture and the second, the sudden break. The fiber strain on the bolt which is responsible for failures of either type is governed by the following factors: (1) Diameter of bolt with relation to thickness of plate; (2) the fit of the bolt in the plate, as too tight or loose in the threads and (3) the shape of the bolt as to whether straight diameter or reduced shank.

All flexible bolts should be released slightly from close contact with the sleeve seat before riveting, because the riveting operation has a tendency to draw up the bolt. The following table gives the approximate clearance between the flexible-staybolt head and the sleeve by turning back, after it has touched the sleeve:

1/8 turn backward	1/64 in. scant
1/4 turn backward	1/64 in. full
3/8 turn backward	1/32 in. full
1/2 turn backward	3/64 in. scant
5/8 turn backward	3/64 in. full
3/4 turn backward	1/16 in. full
7/8 turn backward	5/64 in. scant
1 turn backward	5/64 in. full

A loose fit flexible bolt has a tendency to turn while riveting and the bolt takes much more driving to upset in hole. The fit in the sheet when bolt is run in must be such that the ordinary strength of one hand on a 12-in. wrench is just sufficient to turn the bolt in the sheet.

Bolts should be cut off parallel with the sheet for driving.

When driving up flexible bolts, the holder-on should be held securely against the head of the bolt with a 50-lb. or heavier standard dolly and riveting plug and kept central in line with the riveting blows.

In driving flexible bolts several hard blows must be struck in the center to upset the bolt in the sheet then rotate the air hammer counter-clockwise (this so the bolt does not screw out) on the bolt to knock down the edges.

Flexible bolts must be threaded to make a good fit in the sheet, fits either too tight or too loose are objectionable and cannot be expected to give good results.

Before applying flexible bolts, holes must be blown out with air to remove cuttings left in the holes during the tapping process.

Ends of bolts may be burned off to required length with an acetylene torch before driving.

When applying flexible staybolts covering large areas, the sheets should be held together by screwing a stud through the tapped holes, locating the studs every four or five rows and so spaced to prevent the springing in or out of the sheets when applying bolts or when bolts are being riveted over. All rigid staybolts in close

proximity to flexible bolts should be in place before the application of flexible bolts.

Conclusion

In addition to the foregoing reports, the committee received opinions from other members of the Association. In checking the replies obtained from various railroads, the committee found that a great majority of them followed the method of seating the bolts as outlined in Method (A) of the first paragraph of this report. Therefore, the committee suggested that the Master Boiler Makers' Association adopt Method (A).

Pitting and Corrosion of Boilers and Tenders

Committee reports present practice in repairing boilers and tenders

While the committee has endeavored to report on pitting and corrosion conditionings existing on all roads, obtained as the result of a questionnaire, a difference of opinion was found in some cases. Therefore, this report presents the practice in effect on a majority of roads for repairing locomotive boilers and tenders made necessary by pitting and corrosion of the various parts involved. Reports of individual committee members are as follows:

Report by J. P. Becker

A questionnaire was submitted on the following items which will be discussed in the order noted: (1) Pitting and grooving in boiler courses, (2) life of fireboxes, (3) life of flues and mileage between resetting of flues, (4) pitting and corrosion of locomotive tenders, (5) storing of boilers to prevent corrosion, and (6) the use of treated water and continuous blow-off.

Pitting and Grooving in Boiler Courses—Pitting and corrosion in boiler-course shell plates, usually confined to the area adjacent to waist-sheet supports, caulking edges, edges of washout plug holes, corrosion or grooving of sheets on the water side at the mud ring, front and back flue-sheet knuckles, etc., is caused by strains or stresses in the metal during the fabrication and when the boiler is in service. Due to the repeated changes of temperature in the boiler, a continual expansion and contraction takes place in the plate which causes the structure of the metal to break down in small localized areas on the water side of the plate, thereby resulting in pitting. These pits are usually located adjacent to waist-sheet angles where an added strain is imparted to the sheet.

Where right-angle flanges are turned on front and back flue sheets, it was found that cracks and corrosion existed on the bottom of the front flue—sheet flange radius and at the top and bottom flange radius of the back flue sheet. This condition was found in sheets of ½ in. to ¾ in. in thickness.

The flanging operation opens up hair-line cracks on the outside radius of the flange. Hair-line cracks were also found to radiate from rivet holes and staybolt holes due to improper fitting up of the sheets. These small cracks invite intercrystalline corrosion. Intercrystalline corrosion will also exist when the metal has been strained during fabrication such as rolling, punching, flanging and fitting up.

It is recommended, where excessive cold working or hot or cold flanging of the metal is done, that the sheet be stress relieved by annealing.

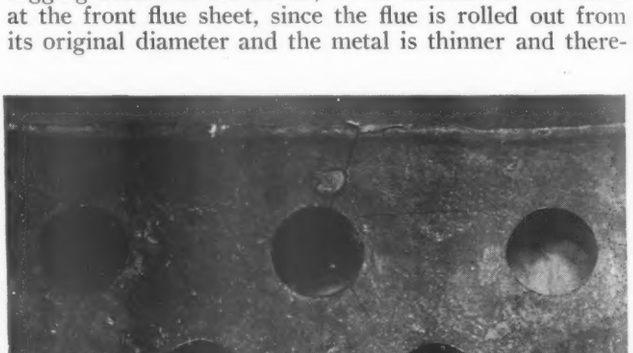
Life of Fireboxes—Prior to the time of establishing systematic feedwater treatment, side sheets in locomotives with 100 sq. ft. of grate area and 255 lb. per sq. in. boiler pressure required new side sheets in one to three years. While there is no doubt that more or less pitting and corrosion is set up during the fabrication, it must be admitted that the degree of cleanliness and attention to maintenance of the boiler is the principal factor in eliminating premature repairs.

Life of Small Flues and Mileage Between Resetting.—The elimination of pitting or grooving of flues is still a problem; however, the treatment of boiler water has reduced the tendency of pitting in flues.

Effect of Treated Water on Life of Boiler Parts

	With untreated water, years	With treated water, years
1—Life of fireboxes	4 to 8	10 to 20
2—Life of small flues	8 to 15	10 to 20
3—Time between resetting of small flues	1 to 2	3½ to 5
4—Life of superheater tubes	8 to 15	10 to 20
5—Time between resetting of superheater tubes	1 to 2	3½ to 5
6—Life of arch tubes	1 to 2	4 to 5
7—Life of syphons	3 to 6	10 to 15
8—Hours of miscellaneous hot work, per locomotive per month	120	60
9—Hours of bombarding sheets, per locomotive per year	96	24

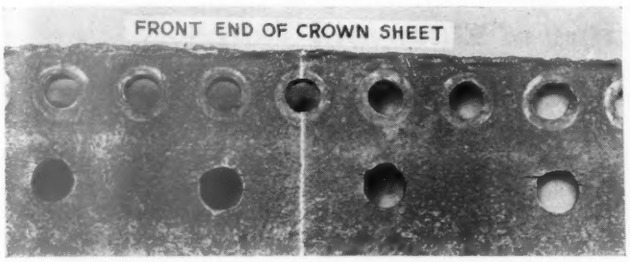
When long flues are placed in a horizontal boiler, sagging occurs at the center, which concentrates a stress at the front flue sheet, since the flue is rolled out from its original diameter and the metal is thinner and therefore subject to grooving. However, the end of the flue in the back flue sheet is strengthened by swedging to a smaller diameter, consequently increasing the original thickness of the metal. In the case of retipped flues, the safe end or new flue tip is applied at the back flue sheet, while the old part of the flue is rolled into the front flue sheet. In cases where grooving took place around the flue at the front flue sheet, a short piece of



Intercrystalline corrosion at circumferential seam

flue was rolled into the end of the flue and the strain was thrown over a greater area of the flue, whereas it had previously been concentrated at the edge of the flue sheet, and grooving resulted.

Pitting and Corrosion of Locomotive Tenders—The pitting of tenders in the water space is primarily due to



Cracks around crown bolts on the water side

water conditions, and may be corrected by treating the water or cleaning the surfaces and painting them with a protective covering. Corrosion in the coal space is due to the liberation of the sulphuric acid in wet coal. This condition can be practically eliminated with paints that are made for this particular purpose.

Storing of Boiler to Prevent Corrosion—A boiler when stored dry and clean will show only a minimum of pitting and corrosion, but when permitted to stand with moisture and dirt in them, they deteriorate very fast. It has been noted that a boiler in service properly maintained has shown less deterioration over a given period than a boiler used occasionally and indifferently maintained, which would also indicate that proper attention paid in servicing a boiler when stored, will pay dividends when the boiler is again returned to service. When it is decided to store a locomotive for a reasonably long period, the boiler should be washed and thoroughly cleaned on both fire and water sides, after which the dome cover and washout plugs should be expeditiously applied. Then the boiler should be steamed up to working pressure and blown down as hot as possible, thus permitting the high temperatures in the boiler to absorb all moisture. At this time a washout plug at the lowest point should be removed; also, all other places where water might be trapped should be drained. When it is ascertained that all the water is removed from the boiler, the washout plug should be replaced. The boiler will then cool off naturally, removing all possibility of sweating or trapping air, and will remain in this condition indefinitely without deteriorating.

Treated Water and Continuous Blow-Off—The application of continuous blow-off to locomotive boilers has proved to be very successful. On one division, locomotives were unable to make the next water stop when manual blow-off was used, but with the application of the continuous blow-off system, no difficulty was experienced with an adequate water supply between water stops. In recent test conducted on locomotives that were washed every 10 days, they have run 30 days before requiring washing after the application of continuous blow-off. This, however, did not dispense with periodic manual blow-off on the road, but it did reduce the number and duration of blow-offs approximately 75 per cent.

In summarizing the questionnaire, in order to ascertain the increase in life of various boiler parts since the advent of chemical treatment for boiler water, the results given in the accompanying table were obtained. The treatment of water with chemicals alone should not be given the entire credit for longer life and additional mileage of fireboxes and flues. Equal credit should be given to adhering to regular washout periods, following a definite schedule of blow-off on the road and at terminals, and complying with the method of treating water as recommended by the chemist. There is every reason to believe that repairs or renewals due to pitting or corrosion can be practically eliminated by scientific water treatment and constant supervision to see that all details relating to water treatment and care of boilers are complied with.

Report by W. B. Graham

The Missouri Pacific started the scientific treatment of boiler feedwater about six years ago, and there has been a very material reduction in the corrosion and pitting of our boilers, firebox sheets and flues. From a practical standpoint, the boiler department on our rail-

Comparing Operating Costs at Present Time with Conditions Prior to Extended Boiler Washout Periods

Number of boilers washed year 1931	22,149	
Number of boilers washed year 1937	2,465	
Average miles between washouts 1931	450	
Average miles between washouts 1937	3,795	
Total locomotive miles year 1931	9,968,922	
Total locomotive miles year 1937	9,355,500	
Number of boilers that would have been washed for 1937, based on average mileage between washouts in 1931, if treated water had not been used—(9,355,500/450)	20,790	
Number of boilers actually washed year 1937	2,465	
	18,325	
Annual saving in boiler washing (@ $3.50 per washout)		$64,137.50
Average months between flue settings prior to treating of water	25.8	
Average months between flue setting subsequent to starting of water treatment	44.9	
Increase in flue life since water treatment started	19.1	74 per cent
Average miles between flue setting prior to treating of water	83,163	
Average miles between flue setting subsequent to starting of water treatment	136,649 53,486	65 per cent
Number of engines that would have required flue reset in 1937 if untreated water had been used, based on average miles between setting prior to use of treated water (9,355,500/83,163)	112	
Number of engines requiring flues reset in 1937, based on average miles between setting since start of water treatment (9,355,500/136,649)	68	
Decrease	44	
Savings in cost of resetting flues 1 year (44 × $500.00)		22,000.00
(Note: Number of engines that actually had flues reset year 1937—57)		
Number of broken staybolts reported year 1931	839	
Average locomotive miles per broken staybolt reported	11,882	
Number of broken staybolts that would have been reported in 1937, based on average miles per broken bolt in 1931 (9,355,500/11,882)	787	
Actual number reported broken in 1937	661	
Decrease due to use of treated water	126	
Annual saving in broken staybolts (@ $1.00 per bolt)		126.00
Wages of running repair boiler forces year 1931	$90,839.92	
Wages of running repair boiler forces year 1937 (based on rates of pay in effect year 1931)	71,657.52	
Saving in wage of running repair boiler forces		$19,182.40
Grand total savings		$105,445.90

roads, by close supervision and compliance with instructions from the chemical department, can more than double the life of the flues, fire boxes and boiler sheets. The blow-down system as prescribed by the chemists in connection with the water treatment has been of great benefit, and a large saving in money over the lines that I cover in Texas. This is exemplified by the accompanying table.

Prevention of Cinder Cutting of Flues and Tubes

Practices in locomotive design and operation which prevent cinder cutting

Some railroads are experiencing cinder cutting on stoker-fired locomotives with detrimental effect on flue sheets, flues, staybolt and crown-bolt heads and various parts in the smokebox. The committee submitted two reports on this subject.

Report by S. E. Christopherson

Cinder cutting of present-day intensity in our modern coal-burning locomotives is due to the velocity imparted to the cinders by improper draft and by locomotive operation at high speeds and heavy tonnages. Most locomotives in high-speed service and making long runs are stoker fired and free steamers. Therefore, the high draft created by the locomotive has a permanent bearing on cinder cutting, since the faster the draft ejects the gases and cinders, the greater will be the amount of air that passes through the firebed; consequently, a much higher speed is developed by the cinder and the quantity is increased, thereby resulting in increased cinder cutting. With high draft on locomotives worked at full capacity, with little or no change in drafting arrangement, we should bear in mind that the advent of this problem of cinder cutting has coincided with the change in operating conditions.

It is the opinion of the committee that the cause of cinder cutting is in the front end. Under present-day operating conditions, which require maximum horsepower and the use of high back pressure to meet the desired result, it is impossible to eliminate cinder cutting; however, it could be reduced to a minimum by the engineer without reduction in speed. It is a known fact that, where exhaust pressures are controlled by the engineer from observation of the back-pressure gage or by mechanical means, there is a decided drop in the speed and amount of particles of coal being carried over the arch.

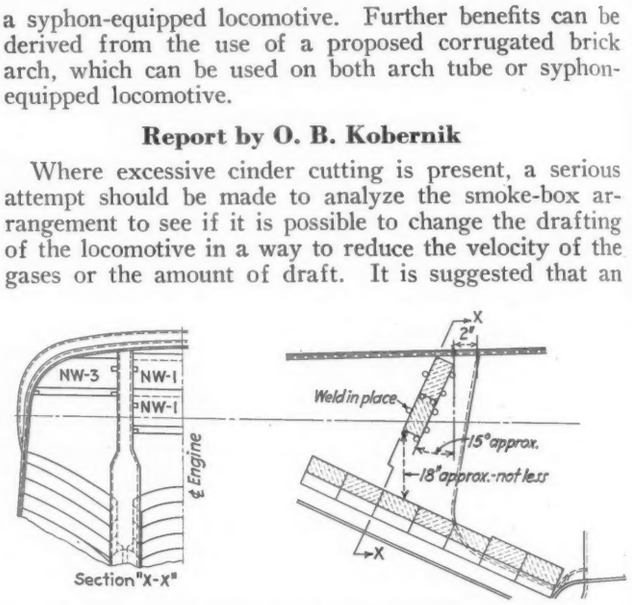
Various remedies to control or eliminate cinder cutting have been tried, but with very little success. These include lowering the arch tube at the door-sheet end, and reducing the number of bricks in the arch (in some cases it was reduced from ten to five in a row, but the steaming of locomotives was impaired and there was no help on the cutting). Beads welded in front of staybolts and crown bolts have diminished the cutting but never prevented it.

Where flue sheet and flues have been affected seriously by cinder cutting, a method has been found which has proven beneficial. This is the use of a baffle brick arch shown in the drawing, especially on syphon-equipped locomotives. This arrangement has been in service on one railroad for about one year; its use has eliminated cinder cutting, plastering or honeycombing of flues. Previous to this application, the expected life of flues was about 28,000 miles.

Where cinder cutting has worn staybolts and crown bolts, this baffle brick arch should give good results on a syphon-equipped locomotive. Further benefits can be derived from the use of a proposed corrugated brick arch, which can be used on both arch tube or syphon-equipped locomotive.

Report by O. B. Kobernik

Where excessive cinder cutting is present, a serious attempt should be made to analyze the smoke-box arrangement to see if it is possible to change the drafting of the locomotive in a way to reduce the velocity of the gases or the amount of draft. It is suggested that an analysis of the actual gas areas be compared to those recommended by the A. A. R. as contained in the recommended revision of the Master Mechanics' Manual. If, as is generally the case, it is found that the stack and nozzle can be changed and a fuel saving realized, the result will naturally be a lower firing rate and less stack loss, with an attendant reduction in cinder cutting.



Baffle brick arrangement, in syphon-equipped firebox, for reducing cinder cutting

Under present conditions of operation, which require sustained horsepower and the use of high back pressures to meet the desired schedules, it is virtually impossible to eliminate stack loss entirely or overcome all cinder cutting. It is noteworthy that cinder cutting is less on those locomotives whose fuel performance is the best, this indicating the benefits of proper drafting.

Where cinder cutting has worn side sheet, crown sheet or syphon staybolt heads, the most effective means we have found of reducing this wear is by application of half-moon shaped beads of electric weld at the back side of staybolt heads approximately ¼ in. from edge of staybolt head. These half-moon heads of weld will be worn in time by the abrasive action of cinders and must be replaced. Straight welded beads have been tried in place of the half-moons but the straight bead did not give as much protection to the staybolt head.

Cinder cutting of syphon flanges has been largely overcome by applying vertical welded beads to the flanges. These beads of weld are also ¼ in. high and spaced approximately 10 in. apart. This breaks up the flow of cinders along the syphon flange and decreases cinder cutting at this location.

Flue sheets have not been seriously affected by cinder cutting; however, rivet heads and flange knuckles are affected, but no means of reducing cinder cutting at this location have been established.

Small tubes located near top of flue sheet on both sides of center line have been cinder cut on the inside of the tube at the bottom where the prosser recesses the tube. On some engines cinders have cut entirely through the small tubes after about 80,000 miles service. It is believed this condition can be overcome by raising the height of arch one brick after 40,000 to 50,000 miles service. This will change to some extent the direction of cinder travel, spreading the effect over a greater area, thereby reducing cinder action at any one location to the extent it would not be necessary to renew flues due to cinder cutting between shopping periods of engine.

To decrease cinder cutting of the boiler front, door and smoke-box ring, a 45-deg. iron casting can be set at the bottom of the smoke box against the boiler front. This casting has a 2½ in. by 2½ in. angle iron bolted to the top edge to deflect the cinders from the boiler front. This has helped to reduce the cinder cutting to some extent but has not eliminated it altogether.

Front-end doors have been protected by a baffle cut from such second-hand material as side sheets, to fit the inside diameter of door. This baffle plate is secured to the door by four studs with spacers between the door and plate. The spacers on the two top studs are longer, which allows the plate to set at an angle, the top of plate being about 5 in. from the door.

As an experiment, about a year ago a special curved deflector was welded to the edges of smoke-box liner and to the 45-deg. iron casting for the purpose of deflecting cinders toward the center of smoke box. This deflector has been effective in decreasing cinder cutting in the front end.

It also seems reasonable to assume that cinder cutting of smoke box in front of the diaphragm plate can be materially decreased by application of angle irons just ahead of diaphragm plate, formed to the radius of smoke box and extending from the bottom of the table plate to the top of the diaphragm plate.

Heads of cylinder-saddle bolts, which are subject to cinder cutting might be protected by a V-shaped plate secured back of the exhaust pipe and extending to the under side of the table plate. This plate would prevent the sudden interruption of the draft at the exhaust pipe, and permit the smooth flow of gases and cinders.

Cinder cutting has been found at the back face of superheater-headed flange joints to steam pipes. This may be overcome by the application of a plate shaped properly to fit the neck between the flange and header. The diaphragm plate would then be fitted to this plate instead of to the header.

Prevention of Cracks in Outside Throat Sheets

Practices which prevent cracking in the upper section of the throat sheet and around staybolt holes

It is universally recognized that the primary cause of cracked throat-sheet wings, that is, the upper section of the throat sheet, is the restricted contraction and expansion which takes place in that area due to the necessity of design wherein a circular barrel is joined to the rectangular firebox. The close proximity of the joints, throat sheet, barrel, and firebox casing restricts the expansion and contraction to a small area between the joints.

Supplementary Causes of Throat-Sheet Cracks

(a) *High Tension and Stresses*—The tendency of the irregular shape at the focal point of failure, that is, the throat-sheet knuckle, to straighten out horizontally due to temperature changes when the boiler is going from zero to full pressure and when returning to normal when cooling down, result in high stresses which cause failure. The more often and more sudden such temperature changes occur, the earlier will fractures develop.

(b) *Flanging Stresses*—Throat sheets, because of their peculiar shape are subjected to severe flanging strains, especially when fabricated by the one-operation method. Flanging of throat sheets should be a two-operation process, flanging the yoke first then reheating the plate for a second operation of flanging the sides. This would greatly minimize the strains.

(c) *Improper Fitting*—Pulling the wings and flanges into position by the aid of bolts and clamps, assisted by local heats from the acetylene torch will set up concealed strains. Hammering or forcing the sheet into position at a blue heat should be avoided at all costs. After such fitting up, the sheet should be removed and normalized in a furnace.

(d) *Restricted Movement of Boiler on Frames*—Over the length of the entire boiler, the expansion will be in some instances as high as 1¼ in. From the time the boiler is fired up this reaction is continual. It is therefore obvious that sliding blocks must be kept well lubricated and in a free operative condition.

(e) *Frequent Cooling Down of Boilers and Rapid Firing Up of Boilers*—These are factors which have a tendency to increase and aggravate expansion and contraction. Extending wash out periods to thirty days, longer locomotive runs to more than one division, and elimination of terminal cool downs by the use of direct steaming will have a beneficial effect upon these sheets and prolong their life. Strict attention should always be given to the practice of blowing off, filling of boiler, and firing up, so that the temperature should be changed gradually in order to give the plates a chance to expand or contract as normally as possible.

The committee has received many helpful suggestions which divide themselves into three groups: (1) Methods of repairing existing throat sheets; (2) change in design for riveted type of throat sheets; and (3) suggested design for welded type of throat sheets.

Method of Repairing Existing Throat Sheets

(*a*) Slight checks should be veed out to the depth of the sheet and welded with the electric arc. Do not reinforce the weld as it stiffens the plate at the section and cracks will develop along the side of the weld.

(*b*) When checks extend half way or more through the sheet, vee out the cracks, weld and apply a cover patch between the joints of the barrel and firebox casing on the inside of the boiler if accessible; if not, apply it on the outside. Rivets in this patch should be staggered between those of the barrel and the casing.

(*c*) If the sheet is heavily cracked, remove and apply a new wing section. Some prefer to lap the bottom joint and rivet it, considering this as an unstayed surface. It is the opinion of others that a welded joint made through the knuckle is adequately stayed, is economical and easy to apply. When a welded joint is used, the joint should be cut in a diagonal direction.

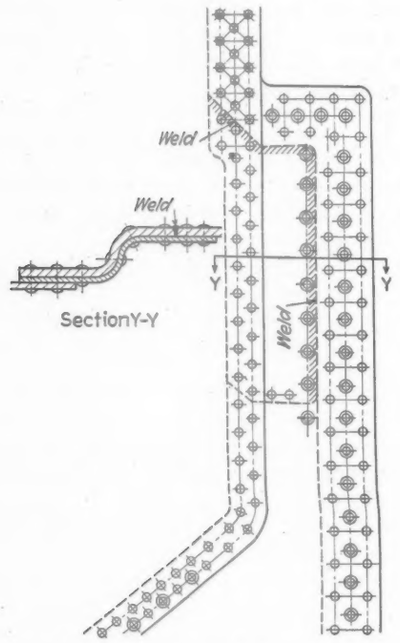


Fig. 1—Reinforcing liner applied to the water side of the outside throat sheet

Throat-sheet wings should have as near a perfect fit as possible to minimize fitting strains. A good method is to make a solid ⅜-in. square iron skeleton gage to conform to the shape and outline of the section removed. When the new section is made to conform to this gage, no difficulty will be experienced in fitting in the new section.

The application of reinforcing plates to wing section have been tried with some success, and it is suggested that this be applied as a preventative of cracking to new sheet.

Fig. 1 shows the application of a reinforcing liner to the water side of the outside throat sheet to be applied to all new locomotives when built and to locomotives receiving new fireboxes when the throat sheet is not cracked. This liner should be made of material of the same thickness as the throat sheet, should fit securely to the contour of the sheet and must be flanged with the grain structure of the sheet to receive the best results.

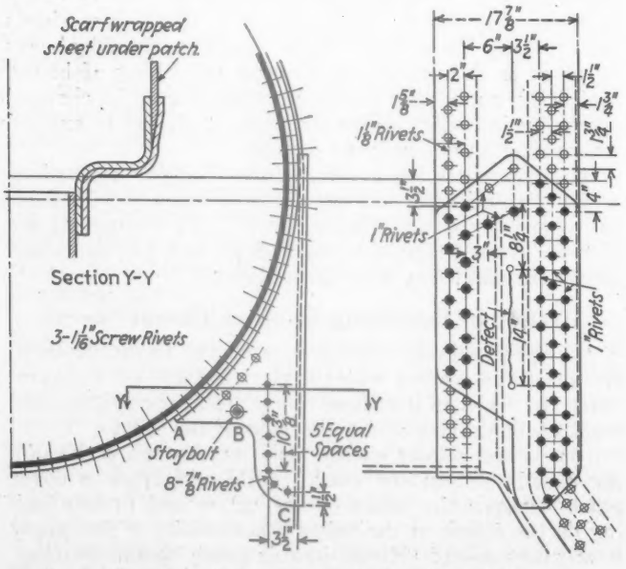


Fig. 2—A patch applied to the outside of a cracked throat sheet

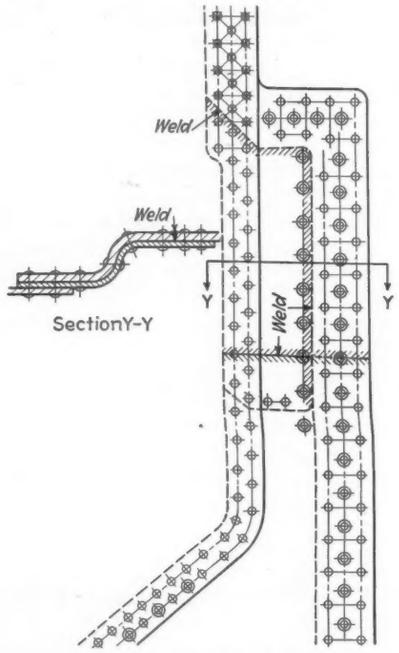


Fig. 3—Throat sheet repaired by welding in a new section and then applying the liner shown in Fig. 1

Two methods of repairing cracked throat sheets with the use of reinforcing patches are advocated, both of which have proven to be satisfactory in service. Fig. 2 shows a patch applied to the outside of a cracked throat sheet. This type of patch can be applied in the shop as a permanent repair or may be applied as a temporary repair in the enginehouse by the use of patch bolts.

A more satisfactory repair can be made by removing the cracked portion of the sheet, welding in a new section as shown in Fig. 3, and applying the reinforcing liner shown in Fig. 1 to protect the weld. This form of repair can only be made when the firebox sides and tube sheets are removed.

Fig. 4 shows a one-piece side-and-wing section with a welded joint between the first and second rows of staybolts. This flanged section would take care of the cracking in wings and ligaments between the outer rows of staybolts and the throat sheet.

Change in Design for Riveted Type of Throat Sheet

Your committee is indebted to G. M. Wilson, General Boiler Superintendent, American Locomotive Company for his suggested design of riveted throat sheet which has considerable merit and embodies a possible solution to this problem. He states: "Assuming the cause is due to design, the design makes necessary the usual shape (knuckle) at which point fractures develop.

"Now if we redesign the flanges so as to eliminate the knuckle (double abrupt bend) by making a straight surface horizontally, we then remove the cause." The method used in so doing is shown in Fig. 5.

Suggested Designs for Welded Type of Throat Sheet

Welding technique is rapidly arriving at a high state of efficiency so that it will only be a matter of time before the barrier against welding joints in throat sheets will be removed. When this takes place it is believed much of our throat sheet trouble will be eliminated. A

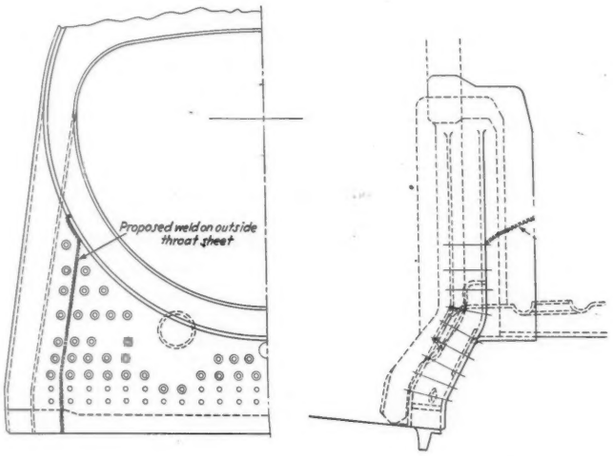


Fig. 4—One-piece side and wing section with a welded joint between the first and second row of staybolts

number of interesting suggestions have been made along these lines.

One suggested design of throat sheet is that in which the yoke of the throat sheet is welded to the barrel of the boiler: "The front flange is done away with and the shell course comes straight back and laps over the throat. It extends through into the water space the full thickness of the shell plate. Then a heavy weld is put on the water side of the joint, and light seal weld is applied to the outside to close any small opening in the joint. The shell course can be jacked down to the outside throat, iron to iron, making a good tight fit. The shell does not depend wholly on the weld, but is supported by a full bearing on the throat sheet which will run from 5/8 in. to 1 in. in thickness.

"If this type of throat were approved, it would be very easy to make and apply. Also, there would be a considerable saving in material, time and labor cost. In old power, now in service, the change could be easily made. If the throat is cracked and the shell pitted, all you would have to do is let the new half shell course extend back through the new throat sheet into the water space and weld it. The combustion-chamber type of boiler is entirely supported by staybolts in the shell and throat, and the boiler without a combustion chamber would have an extra row of staybolts in the throat sheet only."

In the 1936 Proceedings of the Master Boiler Makers' Association, page 88, there is material which can be considered as a worthwhile contribution to the subject under consideration.

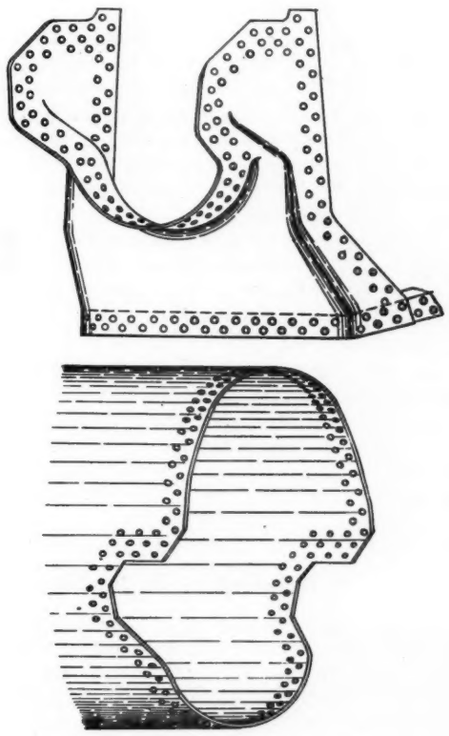


Fig. 5—Proposed design of throat sheet to eliminate the double abrupt bend of the knuckle

"Application of the outside throat sheet, (Fig. 9 of the reference) by the conventional method of flanging, fitting, drilling, reaming, chipping, riveting and calking causes this to become the most expensive member in construction to manufacture and apply.

"A saving of more than 50 per cent in material and labor costs is possible by substituting an electrically-welded throat sheet for the flanged type and a study of this feature reveals that an installation of ample strength and extreme simplicity can be made." [A complete description of applying this welded throat sheet is to be found in the reference just given.—Editor.]

Application of Waist-Bearer Angles

A discussion of the effectiveness of different types of waist-bearer angles or tees

The committee assigned to report on the subject of waist-sheet connections has endeavored to compile information from as many and as wide spread sources as possible, and toward this end a questionnaire covering the various phases of this subject was prepared and sent out. A very gratifying response was received from the members, a large majority of whom reported that they had experienced trouble with the conventional types of waist-sheet connections, and who suggested various changes in design which have been made to overcome or lessen the difficulties experienced with waist sheets.

The rigid construction, resulting from waist sheets

bolted or riveted both to angle irons or tees which are rigidly attached to the boiler shell and to frame crossties, causes strains to be set up in the boiler shell, due to expansion and contraction, which very often results in shell cracks at or near the ends of the angle irons or tees.

The shell cracks which result from this construction range from 1 to 2 in. in length to as much as 10 or 12 in. When such a crack is discovered the engine must be taken out of service and a suitable patch applied before the engine is returned to service, at which time an Alteration Report must be furnished to the Locomotive Inspection Bureau. If the flues are in the boiler and temporary repairs are made by applying the patch with patch bolts, these bolts must be replaced by rivets at the earliest opportunity, resulting in another job of stripping the engine. That trouble of this nature is of common occurrence is indicated by the fact that all of the members consulted reported this trouble except two who reported that there were no rigid waist sheets in use on the roads with which they were connected. A majority of the members indicated that their usual practice was to apply a diamond-shaped patch to reinforce the defect. In some cases the patch is extended from one side of the boiler to the other so as to anticipate cracking at the opposite end of the waist sheet, and also to provide a suitable bearing for the tee iron or angle after the patch is applied. One member reported that engines which gave trouble from shell cracks in recurring locations had patches applied when the engines were shopped and flues removed to do away, as far as possible, with the trouble expense and loss of service of the engine when cracks occurred.

As locomotives increased in size and speed, the trouble experienced with cracked shells at waist-sheet tee irons became so pronounced that steps were taken to improve the condition by changes in design of waist sheets. A number of the members who were consulted stated that whereas older power was nearly always equipped with rigid waist-sheet connections, modern power has floating waist-sheet connections, or waist-sheet tee irons rigidly fastened to a shell. About half of the members consulted, indicated that changes had been made in waist sheets on older power in order to improve conditions, many roads going to floating waist sheets entirely on certain classes of power. Other steps taken to improve conditions were the rounding off of the ends of the tee irons, cutting away the vertical leg of the tee or angle to give more flexibility, the use of laminated waist sheets, and the use of pivoted braces, especially at the guide-yoke crosstie.

In regard to changes in design of waist sheet connections on older power, the Committee was fortunate in obtaining a complete record of shell cracks for an entire class of 100 heavy Mikado-type freight engines, from the time they were built in 1918, to the present time. This information is shown in the accompanying table, and it will be noted that the first shell crack developed in 1923, after which there was an increasing number of shell cracks nearly every year until 1933. In December, 1932, a program was started in which the boilers of this class of engines were cut loose from the locomotive frame. The number of shell cracks occurring at the waist-sheet connections of these engines decreased as these boilers were cut loose, so that for the current year only one shell crack has been reported to date. It should be stated in this connection that as the boilers were cut loose, the connection at the front end of the firebox was improved by the application of a sliding shoe. No trouble has been experienced from increased frame failures or difficulty with smoke arch sheets or rivets due to this change in waist-sheet design. No wearing pads were applied to the boiler shell in this program, and engines which have been in service five years or more since the change was made show no appreciable wear on the boiler shell at the sliding waist-sheet supports.

Good results are reported by a number of members from the use of waist sheets where the tees or angles are riveted, studded or welded to a pad or liner which in turn is riveted to the boiler shell. This construction is, however, more costly and more difficult to fit up properly than the floating type of waist sheet. At this point, a word should be mentioned stressing the importance of proper application of floating waist-sheet connections. An improperly applied floating waist sheet was recently observed on a passenger locomotive where a groove 3/16 in. deep and the full length of the angle had been worn into boiler shell on each side of the locomotive.

With the advent of cast-steel engine beds of great rigidity, the importance of waist-sheet angles or tees is questioned. When such beds are used some members recommend the elimination of waist sheets entirely, while others prefer the usual construction with two, three or even four waist sheets. The use of alloy-steel boiler shells has caused no perceptible change in waist-sheet difficulties. Increased speed of both passenger and freight engines in recent years has been thought by some to increase trouble due to waist sheets, while other members feel that if waist sheets are properly designed and applied, the speed of the locomotive is of little importance.

In connection with waist sheets used with cast-steel locomotive beds, one member reported the use of a novel arrangement where the waist sheet is fastened rigidly to a liner which is in turn fastened to the boiler shell. The lower end of the waist sheet, however, is bolted to a sliding shoe which moves in a bath of oil in a pocket cast in the locomotive bed. This would appear to be the perfect solution of the waist sheet problem, but could only be used on new power.

From the information received with the return of the questionnaires which were sent out, it appears that the members are about evenly divided between those favoring floating waist sheets, and those favoring the type where the waist-sheet angle is fastened to a pad or saddle

Relation of Boiler Shell Cracks to Rigid Waist-Sheet Construction*

Location of shell crack	Boilers Rigidly Attached to Waist Sheets										Floating Waist Sheets					
	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
First course, right side	0	0	1	0	0	1	1	2	5	5	3	2	2	1	1	0
First course, left side	0	0	1	2	2	2	2	0	2	3	1	1	2	2	2	0
Second course, right side	0	0	1	1	1	0	2	2	3	0	0	1	0	3	2	1
Second course, left side	0	2	2	1	2	4	3	1	0	2	5	2	3	1	0	0
Third course, right side	0	1	0	1	1	3	4	0	5	0	1	0	2	1	1	0
Third course, left side	1	0	1	1	2	1	9	2	10	3	4	1	1	2	1	0
Total	1	3	6	6	8	11	21	7	25	13	14	7	10	10	7	1

* Number of shell cracks developed in boiler shells at the ends of waist-sheet angles from 1923 to date on 100 2-8-2 type locomotives built in 1918 and 1918 and fitted with conventional waist sheets riveted to the boiler shell. In December, 1932, these locomotives were equipped with floating waist sheets as back-shop repairs were scheduled. Note the decrease in number of shell cracks after 1932 as floating waist sheets were applied.

which is rigidly fastened to the boiler shell. One member recommended a combination of rigid and floating waist sheets in which the boiler would be attached to the frame at the guide yoke where expansion would be at a minimum, and other waist sheets would be of the floating type. Another member recommended the sliding shoe type of waist sheet described in the preceding paragraph. Where floating waist sheets were recommended, the use of wearing pads on the boiler shell was unanimously favored, both for old and new power. In all cases, proper connections should be provided at mud-ring corners to take care of expansion and to hold the boiler on the frame. No agreement has been reached as yet as to the necessity for waist-sheet connections when cast-steel engine beds are used, but a majority of those questioned favored the use of waist sheets with the one-piece locomotive beds.

In summing up the information received, the Committee believes that:

1—Waist sheets should be used on all locomotives.

2—Waist sheets should be either of the floating type with the boiler free to move longitudinally; or, if a rigid connection is desired, the waist-sheet angle or tee should be attached only to the liner or saddle, which in turn is fastened to the boiler shell.

3—Wearing pads or liners should be used with all waist sheets.

4—Connections at the front end of the mud ring should be of the sliding shoe type with bronze liners. The back end of the firebox should be supported by an expansion plate, as deep as possible to provide flexibility, or by the sliding shoe type.

5—Care should be exercised in applying waist sheets to obtain proper bearing for the boiler shell.

There is evidently no unanimity of opinion among members of the Master Boiler Makers' Association as to just which type of waist-sheet construction gives the least trouble. The Committee believes that much good can be derived from a discussion of the information outlined in this report.

Honeycombing and Slagging of Flues and Tubes

A review of the causes of honeycombing and slagging, and methods of keeping flues, tubes and sheets clean

The economic operation of a locomotive is dependent to a great extent upon the element of keeping the flues, tubes and sheets clean, and the subject of honeycombing and slagging of the flues and tubes is not new. The importance of this subject is made evident by the fact that the Railroad Smoke Association of Hudson County of New Jersey had designated a committee to accumulate data for the enlightenment of its members on this most important subject of honeycombing and slagging of flues and tubes. Their majority report with the minority report as written by William G. Christy, Smoke Abatement Engineer of the Department of Smoke Regulation, Hudson County, New Jersey, were presented to the February 11, 1938 meeting of their association, and published in the April, 1938 issue of the *Railway Mechanical Engineer*.

Individual committee members presented their reports as follows:

Report by E. E. Owens

It is necessary that high firebox temperature plus ash of low fusion temperature plus excess draft exit in unison before honeycomb will form on the flue sheet in the firebox of the locomotive. If any of these conditions are lacking no honeycomb can be formed. For example, if high firebox temperature is not attained then the ash cannot or will not be fused when excess draft is present. If coal having an ash of low fusion temperature is not fired when a heavy ash bed is present along with excess draft, then the existing firebox temperature will not be hot enough to melt the ash. If excess draft is omitted in the firebox through the grates then the ash on the grates cannot be raised above the fuel bed and, since the ash remains on the grates, neither the firebox temperature or its fusion temperature will have any effect upon its structure as long as the draft is even through the entire grate surface and a burning crust of coal is maintained over the entire grate area.

The reason why one coal ash will clinker or melt at a low temperature and another coal ash will not clinker or cannot be fused or made molten under ordinary firebox temperature is governed by the quality of the ash and not by its substances.

It resolves itself down to this—honeycomb is nothing but a misplaced clinker and it is absolutely necessary to have excess draft to manufacture a clinker on the flue sheet. It is claimed by some that faulty drafting appliances in the front end, air leaks in the smoke box, leaky superheater units, leaky fireboxes, especially flues and tubes, are responsible for honeycombing.

While this is true to some extent, as I see it, they are defects that go to set up a condition which causes poor boiler performance which in turn causes enginemen to resort to excess use of the blower, heavy uneven fires and other abuses to the boiler which creates the excess draft necessary to produce clinker on the flue sheet.

Taking everything into consideration, we as maintainers of power can do our part toward holding this trouble down to a minimum by keeping the boiler free from defects and see that it is properly drafted.

Report by J. A. Kahn

Causes of Honeycomb—(1) Honeycomb and slag are very closely related, both containing iron of some form combined with ash and silicon, but, honeycomb having a lower iron content with an increase in percentage of ash and silicon. (2) Any condition that retards combustion causes honeycomb and slag to adhere to firebox sheets, flues and tubes, such as leaky superheater units, leaks in smoke-arch, plugged flues, conditions of arch brick, defective grates, and leaks in firebox. (3) Uneven distribution of fuel causes holes in the fire which increases the velocity of gases in such locations; the high-velocity gases and pick up the plastic ash and deposits it on the firebox sheets, flues, and tubes in the form of slag and honeycomb. An improperly drafted locomotive is also a contributing factor.

Prevention of Honeycomb—(1) Selected coal with a minimum amount of sulphur and iron play an important part in the reduction of honeycomb and slag. (2) Follow good firing practices. Keep a clean, bright, level

(*Continued on page 451*)

K. F. Nystrom, President

E. J. Robertson,
First Vice-President

C. J. Nelson,
Second Vice-President

Holds two-day annual meeting at Chicago, well filled with intensely practical reports and discussions

Constructive Work Continued by

Car Men's Association

THE Car Department Officers' Association held a highly interesting and successful two-day annual meeting September 27 and 28 at the Hotel Sherman, Chicago, the attendance being substantially above expectations, considering the present drastic urge for economy and reduction of traveling expenses. Individual railroads supported the meeting to the extent of sending 115 responsible car department officers and supervisors, and there were 76 supply men in attendance, or a total registration of 191. The intensely practical committee reports and constructive discussions indicated that this association has a very definite place in the railway program to improve car conditions.

The meeting was presided over by President K. F. Nystrom, mechanical assistant to chief operating officer, Chicago, Milwaukee, St. Paul & Pacific, who made the opening address. The meeting was also addressed by Dr. Roy V. Wright, editor, *Railway Mechanical Engineer*. Committee reports were presented on the following subjects: Freight- and Passenger-Car Construction and Maintenance; Shop Operations; Facilities and Tools; Passenger-Train Car Terminal Handling; Lubricants and Lubrication; Interchange; Freight-Car Inspection and Preparation for Commodity Loading; Loading Rules; Billing for Car Repairs; and Painting.

President Nystrom's Address

In opening the meeting, President Nystrom said that railway car men are faced with a number of difficult problems primarily as a result of reduced business and railroad traffic which have resulted in a large amount of deferred maintenance and replacement of equipment. He said that one-half of the equipment in service in 1929, or approximately 1,000,000 cars, will have to be replaced with modern equipment before the railroads will be in a position to handle again with maximum economy car loadings in excess of one million a week. Car designs of even ten years ago are no longer satisfactory and Mr. Nystrom said that car men must be prepared to supply specifications for modern up-to-date equipment which the railroads should acquire as soon as earnings and financial conditions permit.

With regard to maintenance, Mr. Nystrom said that modern cars comprise 90 per cent or more of welding and that former methods of making repairs at many small division repair tracks will eventually have to be discontinued in favor of more extensive and permanent repairs, made on an annual basis at a limited number of shops well supplied with modern welding equipment. This will permit operating cars for a year without attention except lubrication and lubrication difficulties will be solved when the much-desired day comes that roller bearings can be economically adapted to use on freight cars.

Mr. Nystrom also stressed particularly the problem which confronts the railroads in training new car supervisors and craftsmen to fill the vacancies of men now approaching the retirement age. The work normally done along this line has been limited or overlooked entirely in depression years and must be resumed again at the first practicable opportunity, the greatest possible care being exercised both in the selection and training of new supervisors and shop employees.

Remarks by Dr. Wright

In addressing the association, Dr. Roy V. Wright extended congratulations on the character of the program and particularly the discussion which he said was most

stimulating and got down to "brass tacks" on many important matters relating to car construction and maintenance as well as interchange practice. Dr. Wright said that the entire transportation picture has changed during the past few years and a definite demand stimulated for improved services in the handling of both freight and passenger traffic. Railways must face the competition of the highway, and of water and air transport. This means that there must be an unremitting search for ways and means to improve railway equipment and facilities of all kinds.

Dr. Wright said that the railroads must not only provide modern equipment of improved types, but car men are faced with the problem of maintaining and servicing this equipment so as to meet competitive forms of transportation on an even basis. To do this work effectively, both a suitable organization and necessary shop equipment are absolutely essential, and Dr. Wright here concurred in remarks made by President Nystrom regarding the urgent necessity for adequate training of car-department personnel.

In discussing this point further, Dr. Wright said that the greatest problem of the railroads as well as general industry is the human problem and that the supervisor is the key to the situation, since he must interpret management to the workers and workers to the management. Supervisors who become engrossed in mechanical details and overlook the human element are failing in the most important part of their job. Dr. Wright closed with the comment that the difficulties now confronting railway car men are a definite challenge to their thinking and ability and that there is a large place for the Car Department Officers' Association in helping car men meet this challenge.

In replying to Dr. Wright's remarks, President Nystrom paid tribute to the constructive information presented in both the advertising and editorial pages of the *Railway Mechanical Engineer* and said that, without the hearty support of this publication and its editorial staff, the present meeting of the association would not have been held.

Election of Officers

During the meeting, the association elected the following officers for the ensuing year: President, C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago; first vice-president, W. E. Dunham, general superintendent car department, Chicago & North Western, Chicago; second vice-president, J. S. Acworth, superintendent of equipment, General American Transportation Corporation, Chicago; third vice-president, A. J. Krueger, superintendent car department, N. Y. C. & St. L., Cleveland, Ohio; fourth vice-president, E. S. Smith, master car builder, F. E. C., St. Augusine, Fla., and secretary-treasurer, F. L. Kartheiser, chief clerk, mech. dept., C. B. & Q., Chicago.

The following directors were also elected: H. H. Urbach, mechanical assistant to executive vice-president, Chicago, Burlington & Quincy, Chicago; C. Claudy, master car builder, Grand Trunk Western, Battle Creek, Mich.; P. P. Barthelemy, master car builder, Great Northern, St. Paul, Minn.; S. O. Taylor, master car builder, Missouri Pacific, St. Louis, Mo.; J. M. Brophy, superintendent car department, Illinois Central, Chicago; H. H. Golden, superintendent A. A. R. interchange and accounting, Louisville & Nashville, Louisville, Ky.; W. A. Bender, master car builder, Alton, Chicago; G. E. McCoy, assistant general superintendent motive power and equipment, Canadian National, Toronto, Ont.; E. M. Wilcox, assistant superintendent of equipment, New York Central, Chicago; J. E. Keegan, chief car inspector, Pennsylvania, Chicago; C. E. Strain, superintendent car department, Pere Marquette, Grand Rapids, Mich.; John Gogerty, assistant general superintendent motive power and machinery, Union Pacific, Cheyenne, Wyo.; J. P. Morris, mechanical superintendent, A. T. & S. F., Ft. Madison, Iowa; J. A. Deppe, superintendent car department, C. M. St. P & P., Milwaukee, Wis.; O. F. Davisson, superintendent, Armour Car Lines, Chicago; J. J. Root, Jr., assistant to vice-president, Union Tank Car Company, Chicago; J. W. Fogg, vice-president, MacLean-Fogg Lock Nut Co., Chicago; L. H. Gillick, assistant to vice-president, Vapor Car Heating Co., Chicago.

Recent Trends in Equipment Painting

By L. B. Jenson

Passenger Shop Superintendent Chicago, Milwaukee, St. Paul & Pacific

In the railroad equipment field, you will recall that only a few years back each road had one or two conventional colors. The locomotive was, of course, black, which color was standard from nearly the engine's birth. Passenger cars were more or less painted in the so-called Pullman color on most roads, although some rail-

W. E. Dunham,
Third Vice-President

J. S. Acworth,
Fourth Vice-President

F. L. Kartheiser,
Secretary-Treasurer

roads had their own individual colors, and still maintain them. But during recent years the demand on the railroads by the public for speed changed the painting materially. As each road introduced its new streamliners, the old morgue colors were changed to combinations of lighter colors, and a new alloy, stainless steel, entered into the outside finish of streamliners. In fact, during the past few years the painting of locomotives and passenger cars has become so very important that many railroads have engaged the services of high-class designers to decide on the decorative schemes.

The services rendered by the high-class designers of equipment have been very valuable, inasmuch as their views and thoughts were entirely different from what we railroad men had been accustomed to. That their work was well done is evident in the beauty of the new trains built in the past few years. That the public appreciates these trains is proven by their increased patronage of these trains. However, while the services of these designers has been valuable, the services of the painter foreman has been equally so because it was up to him to carry out the wishes of the designer. This meant that the painter foreman has had new and varied conditions to meet in the application of numerous color schemes to make trains outstanding.

New Paint Materials Must Be Durable

In the new-built trains of today emphasis has been placed on light weight and speed, with the result that many new metals have been employed in the construction of the locomotives and cars. The use of these different materials has created painting and cleaning problems. The attractiveness of the color scheme on trains is lost unless the paint materials which are applied are durable and tough enough to hold their colors during the interim between shoppings. Likewise, the highly colored trains must be kept clean.

Streamlining the modern locomotive, either Diesel or steam, makes it a thing of beauty and an integral part of the train. The new steam locomotive of today, streamlined and having the same color scheme as the cars, completes the artist's idea of beauty in railroad equipment. It has been possible to use the same color scheme and paint materials on locomotives as on cars because the jackets of the new locomotives have been insulated against heat. Again, the attractive value of these locomotives is nil unless the color scheme is permanent so as to permit of numerous cleanings.

The interior finish of passenger cars, whether of wood or steel, has undergone the same radical changes that the exterior has as far as color combinations are concerned. Roads that maintain inside steel finish entirely are, of course, up against the same problems as confront them on the exterior. Proper materials must be made, used and correctly applied so that they will adhere properly, be tough to allow of frequent cleaning due to light colors, and be non-fading. New paint materials introduced during recent years have eliminated much of the trouble formerly caused by steel interior finishes. Nowadays, for example, steel surfaces that are properly prepared before paint is supplied, do not shed their finish when subjected to sudden changes in temperature.

Wood Interior Finish Successfully Bleached

Roads that maintain wooden interior finish have been confronted with many changes during the past few years. The mahogany finish that was standard on many roads for many years is being superseded by other woods. That this has created paint problems is well known at Milwaukee shops where 61 new passenger train cars were built this year in which white maple and walnut finish predominated. To bring about the uniformity and beauty of these woods it was necessary to bleach them. This bleaching was an entirely new problem and there was considerable doubt whether the bleaching would have some detrimental effect upon the succeeding coats. It did not.

There need be little said on the painting of freight equipment except to note that quicker drying materials have resulted in shorter tie-ups of cars on repair tracks. Also, tests have proven that these quicker-drying, sprayed on materials are equal or better than the old-time oil and mineral paints which were brushed on.

During recent years radical changes have been made in the method of applying paint. Spray painting has been adopted by many roads for both exterior and interior work. It is sufficient to state that Milwaukee shops have found their up-to-date spraying systems to be indispensable to the economical operation of their car shops.

The radical changes made during recent years in locomotive and car construction and decoration have brought about great changes in the manufacture of railway paint materials. We now have the synthetics, both colors and clear varnish; the synthetic enamels in gloss, semi-gloss and dull; and the lacquers, which have been standard on some roads, and the improved lacquers. One example of the use of these new products on railroad cars will suffice to show their importance. Roads using the all-welded steel car have found that high lustre finishes bring out and magnify the imperfections caused by welding. By using the semi-gloss or dull lacquers or enamels, the appearance of surface distortions is practically eliminated. Also the painting time is reduced by quick repetition of the coats.

The paint manufacturers have keep abreast of the times by constantly improving and experimenting to give the railroads more durable finishes than they have ever had, which means that equipment can stay in service longer than previously with a good appearance. Each manufacturer, of course, has his own individual lines which he advocates and recommends, but it is only possible for men such as the foreman painter to determine by common interest and study, and by daily contact with painting, the real value of these different materials.

In the foregoing paragraphs I have tried to indicate the importance of a foreman painter's problems and work. Now I want to make an appeal especially to those roads that have dispensed with the foreman painter or better still, with the master painter as he was called some years ago. As you know, a year ago I asked for recognition of the Painter Foremen's Section of this association, and it was agreed that the Car Department Officers' Association would take us under their wing until such time as we could get recognition from the A. A. R., and restore the original painting section of the A. A. R. I endeavored, with the help of others, to revive interest in the painters' association, but did not get far, due to the fact that many of the old time master painters had either retired or passed on, and the younger generation who had taken their place were not given the backing by their superiors, that the former heads of painting enjoyed. In some cases that I know of, the foreman painter had even been dispensed with entirely, and supplanted by either a lead man or the painting is just a craft under some other department or general foreman.

Painting Supervisors Should Receive More Recognition

If there was ever a time that the master painter or foreman painter, whichever you please, is needed, it is now. With the many intricacies of painting, a knowl-

edge of the materials and methods being used on high-class equipment is most essential. While paint and painting is not an expensive part of the repairs to cars, it can be made so very easily by the wasting of paint material and its wrong application, bringing about cracked and chipped surfaces on cars and the necessity of repainting. Unless the proper application of paint material is made, it is a total loss to the public and to the railroad on which it is used. In these times when practicing economy and striving by greater efforts to produce a finished article which appeals to the public is a necessity, the former painter should receive due recognition. Instead of railroads curtailing the services of the foreman painter, they should increase his authority, and make him a component part of the organization with authority in conjunction, if you please, with the chemist, to produce lasting work.

There is no superior officer to a foreman painter who is capable of deciding the proper materials for application to be used on either locomotive or passenger equipment unless he has made a thorough study of painting. Painting is a study by itself and only those who are intimately associated with it day in and day out can make a success of it, and know what is right from wrong. I am proud of the painting on the system with which I am connected, and while I am not directly in charge of painting, I am responsible for it, and take as great an interest in the painting of our equipment as I ever did. Therefore, I should like to urge most strongly that superior officers encourage the restoration of the painters' association, giving the foreman painter the authority to attend meetings, or otherwise assist, so that we may get back again the days when there will be a natural interchange of thought and experiences, and painter foremen are encouraged to make a life study of their work. If the value of this were appreciated by the higher officers, I am sure in my own mind, that there would be no question that the painters' association would be restored to its original status. I am satisfied that this restoration would be a good investment and that it would result in sound economy.

Report of Committee on Lubrication

Types of oil for roller bearings—A method of applying packing to journal boxes

It is hoped during the ensuing year business conditions will improve to such an extent that your committee will be in a position to hold meetings, and by so doing, give the subject more detail study, resulting in definite recommendations which can be presented at the meeting next year. In handling the general subject of journal bearing lubrication, it should be borne in mind that the lubrication requirements of both freight and passenger train cars vary due to difference in local conditions such as extremes in seasonal temperatures, territory through which trains are operated, speeds, track curvatures, etc. The oil-saturated waste method of lubricating car journals is still in more or less general use excepting on passenger-train cars on which roller-bearing assemblies have been installed.

Roller-Bearing Lubrication

The lubrication of roller bearings is not an intricate problem to maintenance forces as the manufacturing and lubricating of roller bearings has been given close study on the part of the manufacturers, and also experts representing the various oil companies together with railroad lubrication engineers. They have developed a grade of oil which will, in their judgment, give the most satisfactory results with the various types of roller bearings. Since the mechanical features embodied in the several types of roller bearings differ widely as do speeds and other operating conditions, it is, therefore, to be expected that several different grades of oil will be required for general use.

We find that there are different methods which may be followed in successfully lubricating roller bearings: All-year oil for both summer and winter service; complete change of oil for summer and winter service; the blending method, which consists of using summer and winter oils, but not making a complete seasonal change. Starting in the early spring, oil additions are made of the summer grade, while early in the fall the added oil is of the winter grade. When complete change of oil is necessary, the seasonal grade of oil is used. In cold climates and where boxes are otherwise likely to collect moisture, it is necessary to guard against this on account of the possibility of losing the oil and freezing the roller-bearing assembly.

There are a number of patented devices in use in which pads, wicks or other mechanical devices substitute for waste. Most of these are either being used for test purposes or are in the experimental stage. However, we know of one large Class I railroad that has equipped 41 suburban coaches with the Kendall lubricator pads. These pads have given very satisfactory results since they were installed, and have now been in service approximately 2½ years.

Saturated Waste Method of Lubrication

The general journal-box assembly used in connection with oil-saturated waste method for lubricating car journals we believe you will agree, is far from being satisfactory. There is room for improvement in properly fitting and maintaining the lid over the journal box opening, and having an effective spring which will keep the lid tight, preventing foreign substances from entering the front of the box. We believe you will agree that in a large number of cases the journal box lids, particularly on freight cars, are not being properly maintained.

The dust guard is another important and possibly, in many instances, a forgotten item in connection with proper journal lubrication. The so-called standard dust guard leaves much to be desired in effectiveness and in doing what is expected of it. This, you will agree, is a very important item in connection with successfully eliminating hot boxes due to dirt or snow entering the box at this location. Therefore, in our opinion, it is of the utmost importance that the dust guards be properly fitted and maintained to promote successful lubrication of car journals.

The proper grade of oil is a very important item in good journal box lubrication. We find that the practice of using new oil for passenger car lubrication seems to be quite general with the majority of railroads.

The quality and characteristics of car oil are of the utmost importance. In summer, or in mild climates, the oil problem in itself is not difficult. In extremely cold temperatures, however, the characteristics of the oil become very important. It is under winter conditions that lubrication troubles multiply. Moisture enters the journal boxes and causes sogginess of packing. A compounded oil that will partly emulsify under such conditions cannot be expected to give the best results. When a car stands for a period of time in extremely cold weather the oil freezes. If the oil is such that it becomes sticky and gummy, trouble with disturbed packing and waste grabs is to be expected. It has been found that in extremely cold weather a cut back or a thinner oil is being used very successfully by adding a small amount to the journal boxes on cars which have stood any length of time and which provides sufficient immediate lubrication to the journals until such time as sufficient heat is developed to provide proper lubrication from the oil in the packing.

There also exists a wide range of opinions as to what constitutes the best waste for packing passenger car journal boxes. The preferences run to skein wool yarn. Axminster yarn, mixed wool waste, spring cotton packing, wool and cotton mix, special waste containing stiff fibrous materials and several grades of cotton.

Spring packing, some wool and some fibre treated wastes have more resilience than others and are the choice where resilience is given a prominent place in waste selection.

In choosing a wool waste for extremely cold regions, the selection should be a waste that is free as possible of loose lint and shredded or fluffy materials, as these have a tendency to break the oil film between the brass and the journal. A number of railroads use a good grade of cotton waste for the reason that it is practically free from lint. However, this kind of waste tends to become soggy when more or less moisture gets into the box.

In the preparation of new and renovated packing all railroads do not follow in detail the standard practice as outlined in Rule 66. One of the large Class I railroads which does not conform in detail with A. A. R. standard practices in this respect, shows an increase in freight service, from 146,659 to 192,034 miles per hot box and a decrease in average train delay per 100,000 miles from 13 to 10 min. in 1937, compared to 1936. In the same period in passenger service, miles per hot box increased from 253,047 to 725,002 and the average train delay per 100,000 miles decreased from 9 min. to 4.

In this method of packing, a suitable size roll of loosely twisted packing of sufficient size to fill the bottom portion of the rear end of box is used. This roll is placed against the back wall of the journal box in order to properly lubricate the fillet end of the journal and to keep out foreign substances. The packing between this rear roll and the wedge at the front end of the journal box is applied in two separate sections as follows: A suitable amount of packing is made into a loosely twisted roll sufficient in size to fill bottom of box, extending about one-half of the distance between the rear packing roll to the fillet of the journal and the collar. A second roll is made in a like manner to furnish lubrication for the balance of the journal extending up to the collar. The ends of the packing in these rolls are tucked down at the side walls of the journal box, and no part of the packing in the box extends above one inch below the center line of the journal.

A suitable and separate piece of packing to form a front plug or dirt seal is placed in front end of journal box. Any loose ends or strands are carefully tucked down at the front end of the box and this plug is not permitted to extend above the balance of the packing in the box.

In addition to using lubricating materials of a good grade and quality, satisfactory journal lubrication depends not only on the proper application of the packing in the journal boxes, keeping it one inch below the center line of the journal to insure against hot boxes as the result of waste grabs, but it is equally as important to insist upon careful attention of the journal box and its contained parts. The journal itself should be straight and perfectly smooth. Too much attention cannot be given to the finish of the journal. The practice as indicated in the Wheel and Axle Manual should be followed in machining axles and finishing journals. Careful attention should be given journal bearings, wedges and dust guards, when applied in connection with wheel changes, to insure that journal bearings are of the correct length and have a positive initial crown bearing and that the wedges should also be carefully checked in connection with periodic repacking journal boxes and all defective parts renewed.

The report was signed by Chairman L. R. Wink, assistant superintendent car department, Chicago & North Western; P. Maddox, superintendent car department, Chesapeake & Ohio; P. P. Barthelemy, master car builder, Great Northern; F. B. Lewis, general car inspector, Union Pacific, and R. Knorr, supervisor car repairs, Erie.

Discussion

In discussing the report on lubrication, President Nystrom said that roller bearings of today are either more reliable than those applied ten years ago, or the

railroads know how to take better care of them. The Milwaukee has 200 passenger cars equipped, with a record of two years' actual service without a failure. Condensation in winter sometimes causes water to accumulate in the boxes and wash out the lubrication, a condition which must be avoided by periodic checking, especially in the winter time. In changing wheels at shopping periods the roller-bearing units are removed from the journals, cleaned thoroughly and inspected with the utmost care to discover defects which would otherwise cause service failures. Defective roller bearing parts are replaced. This careful inspection and renewal is one of the prices which must be paid for the satisfactory performance of roller bearings in railway service.

F. G. Moody, master car builder, Northern Pacific, said that, with A. S. F. type roller-bearing units, the practice is to supply oil every 30 days. The oil level is checked once a week and a minute inspection made at each shopping. During the past year two oils were used in lubricating these roller bearings.

One member said that "Roller bearings are the answer to the car man's prayer," since with proper attention they entirely overcome hot box difficulties. C. A. Mick, mechanical inspector, Chicago, Burlington & Quincy, said that roller bearings are checked for oil level on Burlington three-car trains every 4,000 miles and on the larger trains once a week. Wheels are changed on an average every two months or 60,000 miles, thus automatically preventing water difficulties. A seasonal oil is not used. In December, the Burlington starts the addition of blending oil which is used until the middle of March, this blending oil being a good lubricant and giving a quick start.

In discussing the lubrication of freight car journals, one member said that no railroad can be sure it has summer oil in the summer time and winter oil in the winter and that, therefore, a one-year-round oil is desirable. He credited a record of 750,000 miles per hot box to the effective operation of Rule 66, and said that 50,000 miles per hot box used to be considered a good performance. The use of too much oil makes the packing swim and causes waste grabs.

F. E. Cheshire, general car inspector, Missouri Pacific, said that primary difficulty with hot boxes occurs not in winter months as many suppose, but are the worst in June, July, August and September. Mr. Cheshire said that an analysis of hot boxes over a 17-day period on the Missouri Pacific indicated that only one out of four

caused train delays and that the real trouble is usually due to mechanical conditions which must be corrected. He said that the present design does not provide for proper tolerances.

C. A. Mick, mechanical inspector, Chicago, Burlington & Quincy, stated that if the proposed A. A. R. oil specifications are adopted, they will involve either the distillation or chemical treatment process and there is some question if this expense is justified. He suggested the development of specifications for packing as it goes into the journal box, thus permitting individual roads to meet the packing specification with their own combination of oil packing and waste. A motion was passed that this be referred to the A. A. R. Mechanical division.

E. S. Smith, master car builder, Florida East Coast, said that present standard journal boxes will be in service a long time and must be maintained and operated. A. A. R. specifications should be adhered to, particularly with reference to wheel mounting, as he finds hundreds of instances, for example, where wheels are not properly centered as pressed on the axles.

(The committee report was accepted.)

Report on Shop Operation, Facilities and Tools

Jacks, cranes, hoists, trucks, portable electric equipment and welders are discussed

Your committee has been forced to rely solely on correspondence in the consideration of its subject matter and, since the request was made that the committee be concise and cover one or two specific items of particular importance, this report deals with the subject of facilities for freight car repair shops only.

Car Pullers—Modern car pullers will be found very useful as time-savers for moving cars in and out of the shop and spotting them in the various positions, especially where the progressive method of moving cars through the shop is used. There are many efficient types of car pullers available and in use, some of which have been designed and built in railroad shops. The use of car pullers in connection with the progressive system is considered more efficient than tractors since they enable the entire line to move at one time.

Overhead Crane — In designing shops, provision should be made for overhead cranes to facilitate the raising of car bodies from trucks, handling of heavy materials, etc. Such cranes should preferably have runways extending the full length of the tracks on which repair operations are carried out. A lifting capacity of from 10 to 15 tons is generally considered ample with lifting speeds of from 22 to 25 ft. per min. Usually with an increase in lifting speed, the capacity of the crane must be sacrificed. The number of overhead cranes

required in any one bay will depend on the methods employed in routing cars through shop and also the number of cars handled per 8-hr. shift. However, with the progressive system in use, it is generally considered that one crane in a bay can serve up to three tracks, each having a capacity of 12 cars in the repair positions.

Truck Repairs — The use of a portable tripod with suitable chain or ratchet hoists for handling of truck repairs will be found helpful in facilitating such work. Such facility makes easier for the employees the changing out of wheels, truck sides and bolsters, and therefore results in such operations being carried on in less time than where the work must be done by more laborious methods.

Air Jacks—Air jacks of suitable height mounted on low wagons should be used for lowering and raising of draft gears. Where such devices are in use the work of replacing draft gears or removing them for inspection can be carried on more efficiently and in a safer manner than where an ordinary jack is used to carry on the work.

Paint Facilities—Where the design of a shop permits, facilities for painting cars before moving them out of doors are an important consideration. Delays caused by moving cars, ready for painting, from one shop to another are avoided. Furthermore, there is no delay or hindrance to proper painting due to inclement weather which is so often the case where such work is done out-of-doors. With the spray method of painting in general use, it is desirable to confine such work to a certain portion of the shop in which the repairing operations are carried out. Spray booths or hoods only, in conjunction with suitable exhaust fans, will, to a large extent, overcome the objections of spray painting in a shop where other operations are carried on.

High Cycle-Frequency Equipment — Hi-cycle electric drills and reamers are coming into use more and more, and consideration should be given to installing high cycle frequency equipment with suitable outlets along the tracks to allow maximum flexibility in their adaptation. This is especially important where there is considerable steel work to be handled. The high-cycle equipment is generally considered far more efficient and practical than air-driven tools. However, where it is as yet impractical to install such electric-driven equipment, it has been found that rotary air motors give very good results. Some consider the latter to be more efficient and less expensive to maintain than toggle-type air motors.

Gas-Cutting Equipment—In order to get away from the expense of handling acetylene and oxygen in the shops, it is well to give consideration to a central distributing plant. The shop should be adequately piped and have outlets suitably located to reduce to a minimum the amount of hose required by operators of cutting outfits.

Welding Equipment—There is little need to emphasize the growing importance of welding and how costs can be radically cut by its use. However, there are several things to be considered in its application. For example, (a) the power supply should be designed not only for present needs but also for future demands; (b) outlets should be placed in frequent and suitable locations throughout the shop; (c) flexible jigs should be constructed so that most of the welding can be positioned. There are two types of welding machines, viz., alternating current (transformer type) and direct current (motor generator type). Both have their respective merits and these should be weighed before any decision is made. Besides arc-welding machines, there are the several kinds of resistance-welding machines. For light-gage material these have been found to be very satisfactory.

Tractors and Lift Trucks—These are practically indispensable. The latter are particularly responsible for the reduction in cost of handling material on skids or platforms and the moving of mounted wheels to and from wheel shop. The success of the repair or production line is dependent upon the continuous flow of material and supplies. With efficient tractor service go substantial savings.

For such a broad subject, much remains to be written. No mention has been made of heavy equipment such as punch presses, straightening presses, coping machines,

etc., which are essential to every well-organized plant. Suffice it to say that railroads in general are alive to the fact that an economical and efficient shop is one of the foundation stones of a successful system.

The report was signed by Chairman J. A. Deppe, superintendent car department, Chicago, Milwaukee, St. Paul & Pacific; J. H. Gimpel, assistant superintendent car department, Wabash; M. F. Covert, general superintendent of equipment, General American Transportation Corporation; H. S. Keppelman, superintendent car department, Reading, and P. B. Rogers, shop superintendent, Atchison, Topeka & Santa Fe.

(The committee report was accepted without discussion.)

Freight- and Passenger-Car Construction

Suggestions for improvements in rules and standards offered to Mechanical Division

Due to existing conditions on the railroads, your committee has not held a meeting. I have, however, asked the members for recommendations to submit to the general committee for review and the following suggestions are submitted for consideration:

Passenger and Freight Equipment

(1) Some railroads and private car lines are using 1½-in. steam train line; this is inadequate, especially on head-end cars. Certain railroads use the steam-jet air-conditioning system which requires steam to operate and it is felt that action should be taken to have all cars operating in interchange, equipped with a 2-in. line or larger.

(2) Elimination of noise due to buffer stems on passenger cars. At the present time we do not have anything to offer as a remedy, other than to keep them shimmed snugly to eliminate all play possible.

(3) Overhead water tanks should be provided with standard connections and applied so that tanks can be filled from either side, thus to avoid crawling under car.

(4) It is recommended that passenger-car journal boxes be cast with a well or recess on top of the box to which a forged plate can be applied to eliminate wear on top of the box brought about by foot of equalizer.

(5) It is recommended that metal ladders be used on all freight cars, new or rebuilt, and attached to the car at the top above the loading line and at the bottom so that the ladder can be readily removed without entering car.

(6) It is suggested that consideration be given to periodic annealing of the U-shape cast-steel side frames.

(7) It is found that the side walls on Type-E couplers are being kicked out and broken due to insufficient clearance for tail of knuckle. The coupler committee a few years ago increased the clearance, but did not provide enough, with the result that we are still having broken side walls.

(8) Interchange Rule 18, Supplement No. 2, shows certain revisions in regard to condemning couplers on account of cracked side walls due to the knuckle striking and breaking same. I took exception to this defect when it was presented by the coupler committee in 1932 or 1933, and am still of the same opinion that the rule is not yet right even as revised. I still feel that couplers are being condemned unnecessarily and railroads as well as private car owners are paying for couplers that should never be removed from cars, and the same railroads are taking advantage just because the rules permit them to do it; in fact, they are specializing on this defect and I do not believe that it can be shown that a coupler has ever failed due to this defect. I know that the largest railroads in the country are not removing couplers for this defect and they have been running for years with cracked side walls, and it has now reached a point where federal inspectors are reporting as broken all couplers which the rule permits them to report.

(9) It is believed that many hot boxes on freight cars could be overcome if a longitudinal rib were cast inside of the box one inch below the center line of the journal; this will prevent the dope from rolling and the box cannot be packed too high.

(10) It has been suggested that consideration be given to extension of spring plankless trucks.

(11) Another suggestion has been made that center plates be welded in place in order to overcome the many loose center plates we are having.

It is also recommended that welding of many other parts where bolts and rivets are now used be encouraged in order to reduce maintenance cost as well as reducing weight.

(12) Where bolts are now used and it is not practical to weld, it is suggested that rivets be used.

The report was signed by the committee consisting of Chairman J. McMullen, superintendent car department, Erie; C. Claudy, master car builder, Grand Trunk Western; W. A. Bender, master car builder, Alton; J. S. Acworth, supervisor of equipment, General American Transportation Corporation, and J. E. Keegan, chief car inspector, Pennsylvania.

Discussion

In discussing Item 1 of the report, the fact was developed that a number of roads have standardized on 2½-in. steam train lines which show definite advantages for long trains and head end equipment, especially that operating in northern climates. The idea of making this size mandatory, however, was opposed and a motion passed that passenger-train cars for interchange service have train lines and connectors not less than 2 in.

Regarding Item 2 the point was made that coil-spring buffer-stem snubbers seem to be giving good results, especially when the Alemite method of greasing the buffer faces is employed. Adequate lubrication also tends to enable the buffers to slide more readily with respect to each other under the heavy pressures utilized with modern buffer springs. Tight-lock couplers were also mentioned as a positive source of reducing noise.

Regarding Item 7, one member mentioned one instance in which 39 couplers were removed within a comparatively short period at a car inspection point for cracked side walls. Another member stated that if the charge for this defect were eliminated, there wouldn't be one coupler changed in a year for this cause. The motion was seconded and carried that Items 1, 3, 4, 5, 7, 8 and 9 be referred to the Association of American Railroads, Mechanical Division, for consideration and that Items 2, 10, 11 and 12 be called to the attention of the individual railroads for such action as might be deemed desirable. Item No. 6 was referred back to the committee for further study and report at the next meeting.

J. C. Lewis, President

Second annual meeting of Fuel and Traveling Engineers' Association—Program dealing with locomotive design, fuel economy, locomotive and train operation, fuel preparation and firing practice stimulates lively discussions

Locomotive Supervisors Discuss

Fuel and Operating Problems

J. R. Jackson, Vice-President

G. M. Boh, Vice-President

A. A. Raymond, Vice-President

T. Duff Smith, Secretary-Treasurer

At the second annual meeting of the Railway Fuel and Traveling Engineers' Association held at the Hotel Sherman, Chicago, on September 27 and 28, four sessions were devoted to a program of individual papers and committee reports dealing with various aspects of fuel economy and various phases of modern high-speed train operation which are of constantly growing importance. The convention was called to order on Tuesday morning by the president, J. C. Lewis, road foreman of engines, Richmond, Fredericksburg & Potomac, with a registered attendance of about 150, of which over 100 were railroad men.

Interest and attendance were sustained through three sessions on the first day. The morning session was devoted to fuel economy and utilization of locomotives. Three papers on fuel economy were prepared under the general chairmanship of Robert Collett. Two dealing with the part of the engineer and the enginehouse foreman, respectively, in fuel economy were individual papers, and the third dealing with the part of the fuel supervisor and traveling engineer was prepared by a committee. A part of the afternoon session was devoted to two papers prepared by the Committee on Fuel Records and Statistics under the chairmanship of E. E. Ramey. One of these discusses the relative value of quantity vs. cost statistics of fuel consumption and the other deals with the place of the fuel supervisor in railroad operation. The evening session was devoted to the discussion of firing practice, both oil and coal. Wednesday's session was given over to the presentation of two papers on air-brake subjects. That dealing with

the No. 8ET locomotive brake equipment and its relationship to train handling will be abstracted in a later issue.

Addresses were delivered during the convention by J. M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, by Dr. Roy V. Wright, editor, *Railway Mechanical Engineer,* and by Charles F. Richardson, president, West Kentucky Coal Company, a past president of the association. Mr. Richardson called attention to the community of interests between the railroads and the coal miners in trying to bring about a more equitable situation with respect to the marketing of coal and oil, particularly with reference to the unequal incidence of taxation on the railroads and the pipe lines.

Mr. Hall's Address

In his brief address, Mr. Hall stressed the part that traveling engineers could well take in the matter of educating enginemen on safe water level, especially on modern locomotives some of which have extremely long crown sheets with the bottom gage cock and lowest reading of water glasses set at or close to the minimum height above the highest part of crown sheet permitted by the rules—3 in. On locomotives thus equipped especial attention should be called to the safe water-level markings on the back head for the various grades encountered since a comparatively small change in the grade may endanger the crown sheet if only the minimum water level shown by the bottom gage cock and water glasses is carried. Proper use of and attention to the boiler feeding devices and low-water alarms was also emphasized.

Mr. Hall said that, except in rare cases of defects or failures of a type that could not be foreseen, there should never be a low-water boiler failure and that he hoped that all traveling engineers fully recognized it to be an important part of their duties to see that enginemen closely observed the indications of gage cocks and water glasses and lived up to instructions concerning the minimum water level that could safely be carried under various conditions of operation and the procedure to be followed in the event of sounding of the low-water-alarm whistle.

In connection with the latter Mr. Hall said that there seemed to be a misunderstanding among some enginemen as to the time between the sounding of the alarm and the occurrence of a dangerous condition. Some enginemen that he had heard of were of the opinion that they had 15 min. following the sounding of the alarm before an unsafe condition would arise. He emphasized the fact that should the water feed fail when the water level in the boiler was 3 in. above the highest part of crown sheet, even with the locomotive working considerably below maximum capacity, the crown sheet would begin to be exposed in a fraction of this time, that the sounding of the alarm was a signal of real and immediate danger, and that appropriate action should be taken at once in order to avoid disaster.

Mr. Hall said that it was well recognized that traveling engineers generally had a larger territory than one man could adequately handle and the nature and volume of work assigned to them was often such as to preclude the giving of as close contact and personal supervision as could be desired, but that every possible effort should be put forth to instruct the enginemen in safe practices and to see that the recommended practices were observed.

Supplementing his remark that, with the possible exception of very rare instances, there should never be a lower-water failure Mr. Hall cited the experiences of his Bureau in finding contributing causes, or defects of the boiler or appurtenances, the existence of which may have had some bearing on the accidents. He said that in the earlier years in which the locomotive inspection law was effective contributing defects were found in one-half or more of the crown-sheet accidents investigated, that in later years there had been a sharp decrease in this proportion, and that for the last full fiscal year in which statistics are available (1937-1938) no contributing causes were found in the investigations of the five accidents that occurred in that year.

He compared the five crown-sheet accidents due to low water that occurred last year with the 92 accidents of the same character in the fiscal year 1911-1912 and stated further that in that year there was a total of 856 accidents, 91 persons killed, and 1,005 injured as a result of failures of boilers and their appurtenances, whereas in the year just closed (1937-1938) there was a total of 59 accidents from these causes, with 5 persons killed and 59 injured.

In connection with accidents resulting from failures of locomotive parts other than boilers and their appurtenances, generally called machinery accidents, Mr. Hall stated that 839 accidents occurred in the year 1922-1923. These caused 25 deaths and 966 injuries, whereas in the year 1937-1938 the total number of such accidents was 149, with 2 persons killed and 157 injured.

Dr. Wright's Address

Dr. Wright spoke of several aspects of the work of the traveling engineers and other supervisors of locomotive operation which have a direct bearing on public relations as well as on employee relations. In this category are the effect of the work of the enginemen in train handling on the shippers' desires for improved schedules and for the prevention of loss and damage to freight, and the control which the enginemen exercise over the smoke nuisance. With respect to the latter he cited the outstanding results which have been attained in the reduction of railroad smoke in Hudson County, N. J., by the Railroad Smoke Association, an organization of local railroad men under the direction of the Department of Smoke Regulation of the county, and pointed out that too little attention is given to a clean job of firing outside of such restricted areas, with a consequent waste of fuel as well as unfavorable public reaction.

Dr. Wright also referred to the opportunity which the various supervisors of locomotive operation have for improving relationships between the men in the cab and the managements. They are in a position to interpret the needs and objectives of the management to the men in an understandable way and, by the same token, can also bring to the attention of the management an understanding of the views as well as the suggestions of the men.

Election of Officers

Officers and committee members for the year 1938-39 were elected as follows: President, John R. Jackson, engineer of tests, Missouri Pacific. Vice-presidents: G. M. Boh, district road foreman of engines, Erie; W. H. Davies, supervisor air brakes, Wabash; A. A. Raymond, superintendent fuel and locomotive performance, New York Central. Executive Committee, for two years: M. F. Brown, fuel supervisor, Northern Pacific; S. A. Dickson, fuel supervisor, Alton; L. E. Dix, fuel supervisor, Texas & Pacific; J. J. Kane, road foreman of engines, Lehigh Valley. For one year: E. E. Ramey, fuel engineer, Baltimore & Ohio; W. C. Shove, general road foreman engines, New York, New Haven & Hart-

ford; R. S. Twogood, assistant engineer, Southern Pacific; E. F. Allard, general fuel supervisor, Chicago & North Western. T. Duff Smith is secretary-treasurer. On the advisory committee are E. E. Chapman, mechanical assistant, Atchison, Topeka & Santa Fe; J. N. Clark, Southern Pacific; R. Collett, fuel agent, St. Louis-San Francisco; M. A. Daly, fuel supervisor, Northern Pacific; J. E. Davenport, assistant chief engineer motive power and rolling stock, New York Central System; T. C. Hudson, general superintendent, Canadian National; G. A. Kell, Canadian National; J. M. Nicholson, mechanical superintendent, Atchison, Topeka & Santa Fe; A. T. Pfeiffer, road foreman engines, New York Central; F. P. Roesch, vice-president, Standard Stoker Company; T. Duff Smith, and W. J. Tapp, fuel supervisor, Denver & Rio Grande Western.

Abstracts of the papers and reports, accompanied by summaries of the discussions, follow.

Fuel Quantity vs. Cost per Service Unit

Quantity statistics basic but cost figures have supplementary value

Shall fuel performance records be stated in terms of pounds of coal per 1,000 gross ton-miles, passenger-train car mile and yard-engine hour, or in terms of cost of fuel in cents per 1,000 gross ton-miles? This question may be boiled down to fuel quantity per service unit versus fuel cost per service unit, and it appears that the significant inferences to be drawn from the question are:

1—That the best performance in pounds of fuel per service unit may not be the lowest cost performance.

2—That the lowest cost performance is the proper goal for the efforts of the railroad operating personnel.

3—That where there are price differentials on the various grades or sizes of coal the grade that produces the lowest cost performance should be used.

4—That any adjustments that may be necessary in the equipment of the locomotives to make the use of lower-cost grades of coal practicable should be made.

There can be no argument against the use of the grade of coal that produces the lowest cost per service unit if it will prove practicable from the standpoint of operating service requirements and not cost more indirectly or in other directions than is saved on the locomotives. These angles are subject to demonstration from study of test results on the locomotives and analysis of incidental costs, such as for extra handling of the coal, and servicing and maintenance of the locomotives. It will have to be recognized however that opportunities for reducing costs through differential prices on grades of coal are very greatly restricted if not entirely eliminated when a uniform price for "coal for railroad fuel" is enforced—as it has been during periods of operation under coal price codes.

The local employees and the officers in charge of local operations have no control over the qualities and the grades of coal purchased, nor over the prices paid. Their effectiveness in fuel performance can be measured only by the quantities they use in the production of unit service results. They are properly responsible for, and particularly interested in, the record of the unit quantities. They need and want this form of statement of results, and are only incidentally concerned with the cost figures, which should, however, be given them as a matter of general interest.

On the other hand the higher general officers in charge of the management of the railroad, and responsible for the financial results of the operation as a whole, do have some measure of control over the qualities and the grades of coal purchased and some degree of choice, within the limits imposed by the general level of prices, of paying more for better qualities or grades, or less for the less desirable qualities and grades of coal. They are principally interested in the final result stated in terms of cost per unit of service and they need that form of report in addition to the report of quantities used per unit of service.

The views expressed in the preceding paragraphs are particularly applicable to comparisons of performance made over so short a period of time that no change in the general level of prices has taken place. It is obvious that if a difference exists in the general level of coal prices as between two periods that are being compared, as for example, this year vs. last year, the comparisons of cost per unit of service would be entirely meaningless as to relative efficiency of performance without a corresponding statement of the prices for the two periods.

The statistical reports of practically any railroad will disclose marked variations in the average price of coal as charged into the operating expenses as between succeeding years and even as between succeeding months of the same year. This may be due to one or more of a number of varying conditions, such as variation in the proportionate use of different kinds of coal purchased at different prices, or variation in the price of the same kind of coal as between different mines, and variation in the proportionate use of coal from the different mines, or the signing of a new miners' wage agreement, etc. The point here made is that the average price of coal on any railroad is a quantity that varies most erratically due to many factors entirely beyond the control of the personnel responsible for fuel performance, frequently beyond the control of the management as well, and usually without any relation whatever to the quality or grades of the coal or to any feature or condition whatever in any way connected with railroad operation.

The principal purpose and utility of statistical reports of performance is to disclose the trend of the performance, i.e., to show whether or not improvement is being made and at the same time to show, in so far as may be, the factors responsible for the trend. While we believe that the cost data are instructive and well worth the slight additional work required to produce them, they should be used to supplement but not to replace the more stable and fundamental index of performance based upon quantities of coal consumed per unit of service.

There is no intention to deny the value of cost of performance comparisons covering special situations or conditions. For example, the introduction of the Diesel-electric locomotive creates a special situation in connection with which the statement of performance on a cost basis is logically required. This feature is, of course, not particularly important at this time on many railroads for the reason that Diesel-electric locomotives are as yet used only to a limited extent, but the present trend in this direction indicates that in a comparatively

short time their use will materially affect the fuel costs on some of our railroads.

Another rather special situation in which the statistical statement of the cost of fuel per unit of service would undoubtedly be of considerable value is the case of the several railroads that operate in the west and southwest using both coal and fuel oil in their steam locomotives, since it would give the higher officials of those railroads a direct comparative cost per unit of service for both the coal and the oil, assuming, of course, that these railroads would have the quantity of fuel consumed per unit of service worked separately for their oil-burning and their coal-burning territories.

This report was signed by a committee consisting of W. J. Overmire, N. Y. C.; E. E. Ramey, B. & O., and E. G. Sander, A. T. & S. F.

The Enginehouse Foreman and Fuel Economy

Firebuilding, air and steam leaks in the house and crew cooperation his responsibility

By R. K. Thornley
Enginehouse Foreman, Wabash

The enginehouse foreman's success in fuel economy depends on the effective use of personal attributed in business. Good judgment, common sense, honesty, a willingness to learn, the ability to use the experience and good advice of others, are all very important factors towards conservation of fuel.

The amount of fuel consumed in and around the roundhouse that does not produce revenue service direct is a responsibility of the enginehouse foreman, as the fuel is burnt under his direct control. If the facilities involved cause fuel to be burnt unnecessarily, a report of the condition should be made to his superior with a suggestion as to what should be done to make an improvement.

Fire Building

As a rule the lowest paid class of labor employed in the roundhouse is engaged in burning the largest per cent of fuel that is concerned in preparatory service; in a great many instances they require the most supervision as they must be instructed how to do their work. The most economical method can only be developed by the enginehouse foreman making a careful study of the operation so that he can properly instruct those doing the work, then follow the matter up from time to time to see that his instructions are being complied with.

In building fires, if dense, black smoke is emitted from the stack of which the density is greater than grade No. 2 on the Ringelmann chart, the method of fire building is incorrect or conditions or facilities are not equal to the correct method. When unburnt gases are permitted to pass out through the flues and stack as dense black smoke, more or less soot will always lodge against the firebox sheets and the interior of the flues, forming an insulation which is said to be five times more effective than the best asbestos of equal thickness. When this occurs the process of the heat passing to the water in the boiler is retarded and a longer period is required to raise steam pressure sufficient to handle the locomotive out of the house. This means that fuel has been consumed unnecessarily in preparatory service. The soot that passes through to flues, coming in contact with any moisture that may be on the front-end netting, will cause the netting to plug up, retarding the draft on the fire, resulting in fuel being consumed unnecessarily in both preparatory and revenue service, and often is responsible for steam failure. Dense black smoke is a waste of fuel as well as not to the best interest of the community in which the enginehouse is located. The practice of building fires by which the steam pressure can be raised to 100 lb. in the quickest time we find is the most economical.

Air leaks in shop pipe lines are very expensive regardless of whether furnished by an electric or steam driven compressor, as the results of the leaks are measured in dollars and cents, matter not whether paid out for electricity or fuel. Compressed air is the most expensive energy we have in and about enginehouses as the average cost is 11 cents per 1,000 cu. ft. The cost of air and steam leaks are shown in the tables.

Cost of Leaks in Air Piping

Size of leak, Dia. in in.	Number of cu. ft. per month at 75 lb. pressure	Total cost of waste per month, 11¢ per 1,000 cu. ft.
1/2	13,468,000	$1,481.44
3/16	7,558,500	831.44
1/4	3,336,990	370.37
1/8	824,570	90.70
1/16	213,000	23.43
1/32	52,910	5.82

Cost of Steam Leaks

Size of leak, Dia. in in.	Pounds wasted per month at 160 lb. pressure	Total cost of waste per month at 65¢ per 1,000 lb.
1/2	1,219,280	$792.53
3/16	684,290	444.79
1/4	304,820	198.13
1/8	74,650	48.52
1/16	19,280	12.53
1/32	4,790	3.11

On railroads having water treating plants or any other system of water treatment, the enginehouse foreman should familiarize himself as to the operation so he shall know that it is being operated correctly. Water treatment is a very important factor towards fuel conservation. Sometime ago in an address before the American Chemical Society it was said: "In the United States the average thickness of locomotive boiler scale is 1/16 in.; this means a loss of at least 13 per cent in fuel efficiency." It is recognized that a correct system of water treatment correctly used will eliminate scale formation.

Create a Cooperative Spirit

The largest per cent of the fuel is consumed by the locomotive away from the roundhouse, while in charge of the enginemen. However, the enginehouse foreman is charged with the responsibility of seeing that the locomotive has been prepared properly so as to be able to render service economically as well as successfully. To

bring about this condition it is necessary that the enginehouse foreman have the full cooperation of the enginemen; they are the ones who are operating the locomotives burning the fuel and producing the kind of service your railroad has to offer to the public.

The enginehouse foreman should realize that he must take the initiative to create a cooperative spirit by knowing that the locomotive has been properly conditioned before being dispatched, in the way of flues, clean arch, grates and rigging in good condition, front end free from air leaks, interior of cab clean, and all work reported by inbound crew to be completed when consistent to do so. When the enginemen see that the enginehouse foreman is making an effort to have work done to make their jobs a better one, they will cooperate with him or at least the largest per cent of them will, and in turn they will give the necessary information that must be had in making analysis of certain operating conditions. Cooperation when it is sound and enduring must be absolutely voluntary.

After the fuel has been burned a correct system of accounting should be made so that when making a cost study of the fuel the figures shall reflect a true condition. When fuel is burned in yard offices, stations, switchmen's and crossing watchmen's shanties and cabins, cabooses, maintenance of way department service cars, drying sand, enginehouse stoves, or for any purpose other than actual transportation, the charge should be made against the account provided to cover the cost of the particular operation and should not be charged to transportation. In charging fuel to transportation, a distribution between the three classes, namely: switch, freight and passenger should be made in order that the figures shall reflect a true cost.

Discussion

Fire building at terminals came in for most of the comment following the presentation of this paper. Some question was raised as to the ability to fire up locomotives without exceeding the Ringelmann No. 2 smoke. It was generally admitted that under the most favorable conditions such a result could be obtained, but if the job had to be hurried it could not be done.

The tables of air and steam leaks which were included in the paper are posted in blue-print form in the enginehouse of the Wabash where they serve to advise all enginehouse employees of the cubic feet of air or pounds of steam lost through leaks of various sizes and the cost of such leaks in dollars per month. They keep all employees on the alert to note and report such leaks as quickly as they develop.

The Relation of Enginemen to Fuel Economy

Begins with the selection of firemen adapted to the job

By Harley Finberg
Locomotive Engineman, Northern Pacific

The relationship of the engineer and fireman to fuel economy is an alliance that should be originated in the student fireman, then augmented by teaching and experience until the act of saving fuel becomes so natural that it is accomplished methodically without apparent effort. Railway business conditions today are such that, because of long service periods, the majority of enginemen have acquired this relationship to a very lucrative extent. There are a few exceptions, of course, those men not adapted to the vocation who have the initiative but lack the ability to acquire this relationship, in consequence of which their life work becomes a continuation of unpleasantness and hardship, while their employer suffers from the inferior performance in many ways and ultimately in an out-of-pocket loss. Some railroads are correcting this by discontinuing the employment of student firemen who fail to show proper adaption to the work. While this may seem unjust to the man involved at the time, he is really fortunate, as he must seek other employment which may give him more success and happiness.

The railroads face a real task in this matter as the average ages of both engineers and firemen are such that they must all be replaced in a comparatively short period of time.

During the last score of years the engineer and fireman have been assisted appreciably in their labors and efforts to conserve fuel by an outstanding improvement in fuel preparation. Today railway fuel is a cleaner product than can usually be obtained for domestic use, while formerly it was a regular practice for firemen to throw out large size iron pirites and other impurities from the fuel in order to reduce as much as possible steaming and fire maintenance difficulties. No doubt the demand for and success of the finer types of grates installed in locomotives during recent years was to some extent the result of cleaner fuel, as the coarser types of grates were adapted to burning coal containing excessive impurities, but created large ashpan losses, inability to control fires, etc., when well prepared fuel was furnished.

The knowledge and cooperation of those responsible for locomotive conditions affecting performance, particularly steaming, is very gratifying, as all locomotives today steam freely except when occasionally prevented by unavoidable circumstances which are given prompt attention. This is a revolution from former times when some engines failed to steam properly from shopping to shopping, but caused no one concern except the engineer and fireman. To encourage enginemen in studying out and reporting locomotive defects they should be furnished correct information regarding the accuracy and inaccuracy of their reports.

The continued improvements made on locomotives is very encouraging to fuel conservation, especially on the newly designed power, but in most cases the demands made on the old power under present operating conditions are such that there is no opportunity for additional economy by enginemen except the elimination of unnecessary losses. The performance of old power is remarkable considering the increases that have been made in tonnage and speed, but there seems to be no reserve for further increases, which should not be expected unless additional devices for efficiency can still be obtained for this old power.

In order to retain our gains, there should be no let up in the efforts of this association to create interest as

it has and is doing, and the railroads should not cease to do their part both in keeping this association animated and by following its suggestions and recommendations, for, if they did otherwise, things would quickly slip backwards toward the old starting point.

Discussion

That the making of a good engineman starts with the student fireman was emphasized in the discussion and it was pointed out that on some railroads the applications of firemen are not finally approved until the end of a 30-day student period. The importance of engineers and firemen working together was also referred to several times and the fact that, with the exceedingly tight schedules which now prevail in passenger service, it is necessary for the fireman to work with the engineer rather than the reverse, since there is little opportunity for the engineman to favor the fireman as used to be the case.

Where extended locomotive runs prevail, a spirit of cooperation between the crews of adjoining divisions becomes necessary in order that fires may be turned over at the end of each division in good condition for the outgoing crew. Attention was called to the discouragement to which enginemen and firemen are subjected after they have worked together to make the time economically when other members of the train crew and the station employees lose a minute or two or three in handling baggage or express. The engine crew are expected to make up this time, which they cannot do without a discouraging setback in fuel economy.

How the Fuel Supervisor and Traveling Engineer Promote Fuel Economy

Importance of clean coal and correct practices of sizing, loading and handling stressed

Clean Coal from the Mine

On roads where coal is used as the basic fuel, one of the fuel supervisor's outstanding economy factors is that of proper preparation at the mines. During the process of hauling one million tons of coal to its destination for use on locomotives, which in many instances may involve several hundred miles, and which, for example, was purchased on a specification basis of not to exceed 9 per cent ash, should the preparation be neglected to the extent of allowing enough impurities such as are usually known as binder, bone, shale, etc., to slip and run the ash up to say 10 per cent, an additional 10,000 tons of waste matter would be hauled to the point of consumption, this would be equivalent to 200 50-ton cars, being hauled by locomotives consuming other fuel to do the job.

Other items worthy of frequent attention at the mines, are the condition of hopper doors on empty cars arriving for loading; also the condition of cars as to cleanliness, which includes the removal of any dirt or other refuse matter such as tramp iron, and the removal of any ice or snow accumulation. Frozen coal mixed with ice or snow in the bottom of the cars will increase the cost of handling, and the breakage and pulverization at the time of unloading. When loading, the cars should only be filled to the point where none will fall off or be lost in transit or when shifting cars in yard operations.

At mines which produce the softer texture coals, installation of adjustable loading booms will aid materially in the reduction of fines which are due to rough usage. The installation of magnets for the removal of lost mine tools and any other tramp iron passing through with the coal, will usually pay all of the costs connected with this venture within a short time. A pound of this type of material, if placed on the tender of a stoker-fired locomotive may cause several tons of coal to be sacrificed in connection with failures, delays to trains, etc.

Sizing and Preventing Undue Breakage

Breaking or crushing the coal at the mines to the maximum sizes desired for locomotive use will produce less objectionable fines than would result if done at any future time, as the coal coming up from the mine is usually warm and will break down easily without excessive shattering or pulverizing. This will also make it possible to remove the major portion of the incombustible matter while the coal is passing over the picking tables. A better mixture will also be retained while the coal is passing through the various moves of handling.

With the ordinary run-of-mine coal, should the matter of sizing be neglected, separation will increase with each handling, resulting in part of the locomotives receiving the equivalent of screened coal and others a full tank of fines. Increased steam consumption accompanied by excessive wear and tear to stoker, and uneven firing, will prevail in the former and increased stack loss, possible steam trouble and stoppage or honeycombing of flues, with the latter, under certain conditions at high firing rates.

The practice of keeping dumping pits, storage bins or tubs partially filled, will assist materially in the handling of softer texture coals at coaling stations. Shorting or not fully coaling tenders as opportunity presents, will keep coal on the tender moving and reduce packing and air slacking.

Distribution

Where conditions and facilities permit, it may be possible to work out a distribution schedule that will provide for the use of the higher-ash coals on short runs where consumption rates are lowest. A high ash coal that would not interfere on a yard engine consuming three to four tons during an eight-hour trick, probably would present some difficulties on extended locomotive runs involving heavy and fast service with attendant high firing rates, particularly in the cleaning of ashpans and fireboxes of the ash accumulation at intermediate points enroute.

At coaling stations which are equipped with more than one storage and dump track, a more economical mixture may sometimes be obtained by blending the various textures and grades of coal.

Consistent practices should be worked out with the forces at all terminals and outlying points in the direction of a uniform method of handling the work of dumping, firing up and holding engines under fire when necessary. The latter item is very essential on Sundays, holidays, etc. Various estimates ranging from ten to twenty-five per cent have been made by authorities in regard to the amount of coal consumed at and around terminals, in comparison to the total consumption in revenue service, there-

by proving the importance of this factor to possible further fuel savings.

The Road Foreman a Salesman

In addition to his wide practical experience concerning locomotives, and their operation, and to fuel as it fits into the railroad picture from the viewpoint of expense and other angles the road foreman of engines must, in order to obtain consistent and lasting results, be a salesman of no mean ability and versatile enough to attract and hold the interest of the varied types of men who make up the personnel of his enginemen.

Best results can only be expected from men who have at least a fairly good working knowledge of the power plant, in the cab of which they spend a substantial portion of their lives. The program may be started by asking each man a few of the simpler questions which are oft times overlooked entirely, such as, how many and what are the valve and cylinder events for each complete revolution of the driving wheels; the purpose of lap, lead, cutoff and expansion; the care and attention necessary in order to insure good performance from the auxiliary appliances; parts which make up the motion work; gradually working up to questions and discussions relating to the locating of pounds and blows; also helping out with the answers whenever it becomes necessary, as this interest and assistance will have its natural reaction with the men and encourage them in seeking further knowledge for themselves.

The second step, that of the operation, will include all the best recommended practices, both old and new, that will apply to each class of locomotive and the service that it is engaged in, which should lead up to an increased output and efficiency over that of past performance. Some of its angles will shape up in the form of discussions relating to combustion, good firing practices, condensation, superheat, lubrication, boiler feeding, working steam expansively, and many others.

Locomotive operation is an outstanding subject with the road foreman on roads using oil burning locomotives, due to the fuel losses which can so rapidly accumulate in this type of service. Some of the items are, the general method of firing; proper sanding at regular intervals; condition of the brick work; lost motion to the firing valve rigging; and most particularly to the way that the water is carried in the boiler. It is very easy to overpump an oil-burning locomotive on account of not affecting the steam pressure, should any be lost through poor management.

The quality of the results obtained from the foregoing will be most clearly expressed in the next factor which is a natural by-product of the first two, namely, that of clear and intelligent work reports by enginemen. This item has an outstanding influence on enginehouse expense and efficiency, fuel consumption, operation and many others, and it also provides the road foreman with a reliable index as to the general condition of the power on his assignment.

The Road Foreman an Operating Officer

The road foreman also has a very close contact with the operating department, and his regular duties bring him to a point of actual touch with the daily operation. He usually can accomplish something in the direction of fuel saving by giving some attention and offering some advice on such items as the selection and assignment of the proper size and type of locomotive for each job or run; reducing to a minimum the number of locomotives under fire at terminals that will meet requirements; the balancing of freight-train tonnage as far as possible and still meet schedule requirements, having in mind that the running of one or more trains with saturated tonnage in order to make up for several trains which have been operated with extremely light tonnage usually turns out a poor investment, particularly should this train interfere with and delay other trains.

Duplication of stops by freight trains to do work at the same points on road should be checked frequently and kept at a minimum of requirements that will protect car service.

A study of the location of wayside signals in their relation to trains making stops and starts, when they are in stop or proceed position; keeping work trains out of the way of heavy through trains, and limiting the number of track restrictions or slow orders in force for a given period of time on each district, should benefit the operation and react favorably on the fuel performance on the district concerned.

This paper was prepared by a committee consisting of George M. Boh, Erie, chairman; L. E. Dix, T. & P., A. S. Headley, B. & O., and L. D. Burdell, Erie.

Braking of High-Speed Passenger Equipment

The brakes for this service are still in the development stage

Brakes for controlling high-speed trains are still very much in the development stage and there are a number of phases on which development has not progressed to a point where any definite conclusions have been reached. For example, the matter of disc or drum brakes versus wheel brakes, wheel controllers or anti-sliding equipment, etc., are subjects receiving very earnest consideration at the present time.

It is unfortunate that a considerable number of truck-mounted cylinder installations have been devised so that excessive brake-cylinder pressures are required to move the brake shoes against the wheels, thereby greatly reducing the value of the individual car brake with all degrees of brake applications, as well as destroying harmony of action and distribution of brake value in trains including both the body- and the truck-mounted brake equipment. A maximum of 5 lb. pressure in the brake cylinder should be required to move the brake shoes against the wheels.

Tests show that adhesion may range from 5 per cent on a wet or frosty rail to as much as 40 per cent on a well sanded dry rail. The necessity for providing efficient sanding devices is recognized as of vital importance in connection with high-speed train braking. Sanding from the locomotive alone is not sufficient to insure a good rail condition under a long train, as each wheel cleans off some of the sand and the rail condition under the rear portion of the train is a little better than if no sand had been used.

To improve this condition sanding stations have been installed on some of the cars in several of the later high-speed trains, which operate from the control-valve during an emergency brake application. One train being built will have a sanding station in the middle of the train operated by the engineer as well as by the control valve. It would be practicable to consider such applications only to the trains which are made up of cars which operate solely in such trains and which are turned at each end of the run of such trains.

It seems impracticable to attempt to carry sufficient sand on a car to provide for all brake applications. Means must also be provided to prevent operation when not desired, such as when the train is standing, or passing over interlocking plants, etc., entailing more or less complicated mechanism which must be maintained.

In co-operation with the Pennsylvania Railroad the Westinghouse Air Brake Company carried on exhaustive tests on the Wilmington division in the latter part of 1937. Exceedingly short stops were obtained under good rail conditions and with the wheels protected with a Westinghouse device called an anti-wheel slider, and it was established that in order to insure short stops under varying rail conditions an anti-wheel slider is a very desirable device.

It is an accepted theory that the stopping distance of a passenger train should not increase at a much greater ratio than the square of the speed. In this connection, it should be noted that heat is generated whenever the speed of the train is reduced through brake action.

Service or emergency brake applications, braking ratios, in other words, brake-shoe pressures, modify the accumulation of heat, but heat, as such, is inevitably produced whenever the train is stopped. One advantage of light-weight trains not always considered lies in the reduction of heat generated during brake applications. Evidently, in stopping a train from a given speed, the lighter the wheel load the lesser the problem of dissipating the heat created during the stop.

Varying Braking Force During Stops

To accomplish a stop in the shortest distance possible it is necessary to use high braking ratios during the early portion of the stop and to reduce the braking force as the speed reduces to avoid sliding wheels in the lower speed zones. Some of the modern high-speed train brakes are designed to develop as high as 250 per cent braking force at speeds above 65 miles per hour, and automatically to reduce this in two or three steps to about 100 per cent at speeds below 20 miles per hour. This insures a high rate of retardation in the higher speed zones.

In order to reduce the wide range of frictional values at different speeds, one of the brake shoe manufacturers has developed a shoe with carbon inserts, comprising about 13 per cent of the wearing surface. The carbon acts to reduce the surface temperature of the shoe and therefore increases the coefficient of friction at higher speeds without material change at the lower speeds. This makes the brake more efficient in the higher speed zones.

It is impossible to maintain at all times absolute uniformity of retardation for every brake shoe throughout a train, and in order to attempt such a condition various weight cars are in some instances braked at different braking ratios. The condition of brake shoes varies and also the condition of wheels, so that even though each shoe has a design of brake gear and a force applied to bring about as nearly as possible shoe pressures proportionate to the weight on wheels, each unit will not retard at exactly the same rate.

Power units present a more difficult problem, because excessive shoe pressures are necessary compared to shoe pressures on the average car, and which increases the difficulty of providing shoe and wheel metals which will withstand the heat generated under somewhat prolonged or frequent brake applications such as are necessary in moderate grade train operation. It is, therefore, necessary under such conditions to favor the power units in the development of shoe and wheel heat in order to prevent intolerable brake shoe and wheel damage. This, of course, necessitates an increased braking pressure upon the train to offset the underbraked weight of the power units. Under such conditions the potential speeds are governed solely by the ability to control trains within distances provided by block signal systems and the capacity of the braking elements to withstand the heat developed.

This report was presented by J. A. Burke, supervisor of air brakes, Atchison, Topeka & Santa Fe. It was also signed by H. I. Tramblie, C. B. & Q., and A. G. Mueller, air brake instructor, Chicago, Rock Island & Pacific.

Discussion

In the discussion of this paper Lawrence Wilcox of the Westinghouse Air Brake Company called attention to the fact that the objective of the entire development of braking high-speed trains is to keep stopping distances from increasing more than in proportion to the square of

the speed. He reminded the audience that much more time had been available for making earlier developments in passenger braking than has been the case in the development of brakes for the modern high-speed trains. This development has all taken place in about two years. This, he said, must be kept in mind when considering the amount yet to be done before a completely satisfactory solution of the present problem is attained.

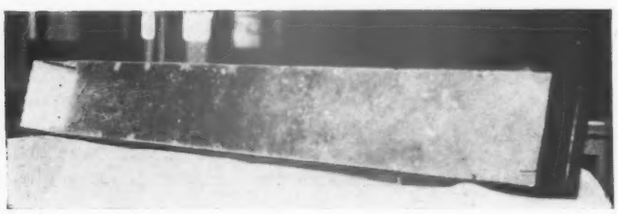
The entire discussion stressed the importance of wheel conditions on the high-speed equipment. Brake-shoe pressures of about 12,000 lb. per wheel were stated as about the limit to which the wheel can be practicably subjected. In stopping a train from 104 miles an hour on a 1½-per cent descending grade it was pointed out that the center of the wheel tread soon begins to show red and that the band of glowing metal gradually extends until it covers nearly the width of the brake shoe and becomes the color of molten metal.

Coal-Firing Practice

Report and discussion relate largely to firing up at terminals

The following instructions (substantially those followed by an eastern railroad) should assist enginehouse forces to avoid violation of good practice.

Engines should arrive on receiving track with enough steam and water to carry them to inspection or cinder pit, whichever is first. Where inspection pits are in advance of cinder pits, engine watchman should be properly instructed in keeping fires so there will not be an undue amount of coke or green coal to be knocked into the cinder pit when the fire is cleaned or dumped.



The diagonal mirror at the left end of the New York Central periscope is of "Herculite," a special heat-resistant glass

Tenders should not be overloaded. Space around tank gates and rear of tender should be kept free from coal. Person coaling tenders should trim them before the engine moves from the coaling station, to avoid waste of coal and possible injury by falling lumps along the right-of-way or at stations.

Fires should be cleaned by the following method: Hoes to be used to pull fires from forward or flue sheet end of the firebox to the back end; then shake the dirt or clinkers through the forward grates until they are bare. It may be necessary at times to pull clinkers through the fire door. After the forward grates have been cleaned and leveled up the hoe should then be used to shove fire and coke from the back end of firebox to the forward grates. The back grates then should be cleaned of dirt and cinders as were the forward grates. Then pull the fire back over the entire grate surface. Do not build the back end of fires any heavier than other parts of the fire on the cinder pit. Shut off blower before safety valve opens.

After the fire has been cleaned and the engine put in the house, and it is found that the engine will not be needed or a mechanical defect develops which will cause it to lay in for several hours, fire should be allowed to die. A metal tag placed on the fire door "LET DIE" will assist the engine watchman.

Engines arriving with a mechanical defect shall be dumped where there is a doubt about having the engine for service under 24 hours.

Ashpans should be thoroughly cleaned, particularly that portion of the pan under the mudring, and all side and end pockets, to insure full air opening to the pan.

All six-day locomotives shall be dumped upon their arrival and so kept until three hours or less of their departing time when weather and enginehouse room or other local conditions are favorable. Grates should be covered to about four inches in depth with coal slightly heavier in back corners and sides, this to stop any circulation and retain heat in the boiler. This takes moisture from the coal, the fire kindles quicker and with less black smoke. Shavings saturated with crude oil are distributed over the top of the coal as placed in the fire box and lighted from the fire door or by the use of an oil torch.

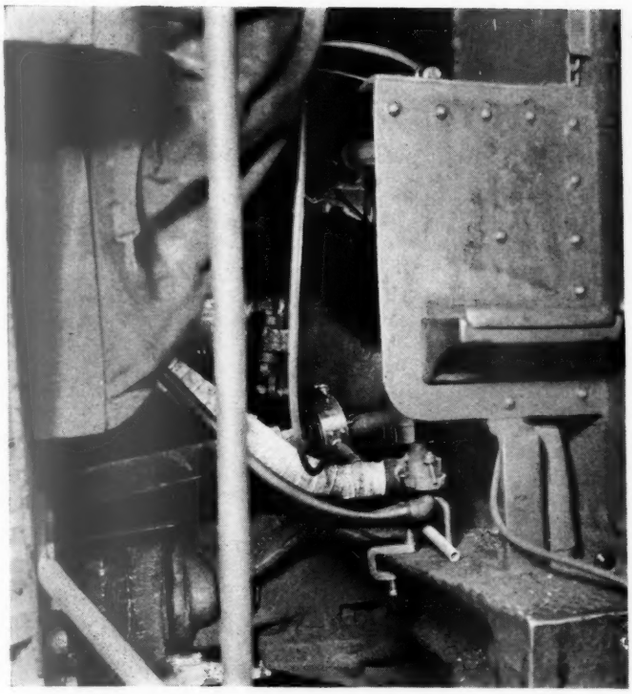
Engine watchmen shall keep fires banked to forward, back and side sheets, allowing the center to die out on all locomotives with a 44 sq. ft. or greater grate area.

On all narrow type fireboxes the fire shall be kept banked ahead, letting two or three grates in the rear of the firebox under fire door die out. Fires banked according to the above should be pulled over the entire surface about one hour before departing time.

Engine watchman should never get steam pressure within 25 lb. of maximum except when safety valves are being tested.

Boilers should never be filled so that water is out of sight in the glass. Anyone working in the cab using

Observing the condition of the fire at the back corners with the periscope



Application of the revolution counter to the stoker drive shaft

the blower to take the gas out shall close blower before leaving the cab, and close the fire door as a protection against fires in the cab.

Don't overload tenders.

Don't allow pops to open unnecessarily.

Don't permit dirty deck or apron.

Don't throw large lumps in fire—crack them.

Don't forget "LET DIE" tag.

Don't forget fuel conservation.

Don't forget safety.

The report was signed by W. C. Shove, chairman, N. Y. N. H. & H.; M. B. Morrow, Northern Pacific; L. D. Burdell, Erie; S. M. Roth, Western Maryland; C. C. Connell, Wabash; J. J. Kane, Lehigh Valley; M. Cavanauh, C. St. P. M. & O.; H. Malette, St. L.-S. F.; W. B. Kilgore, C. & O.; J. J. Millett, Illinois Central; C. S. Mikles, N. Y. O. & W.; S. T. Reid, Michigan Central, and Wm. Small, B. & M.

Discussion

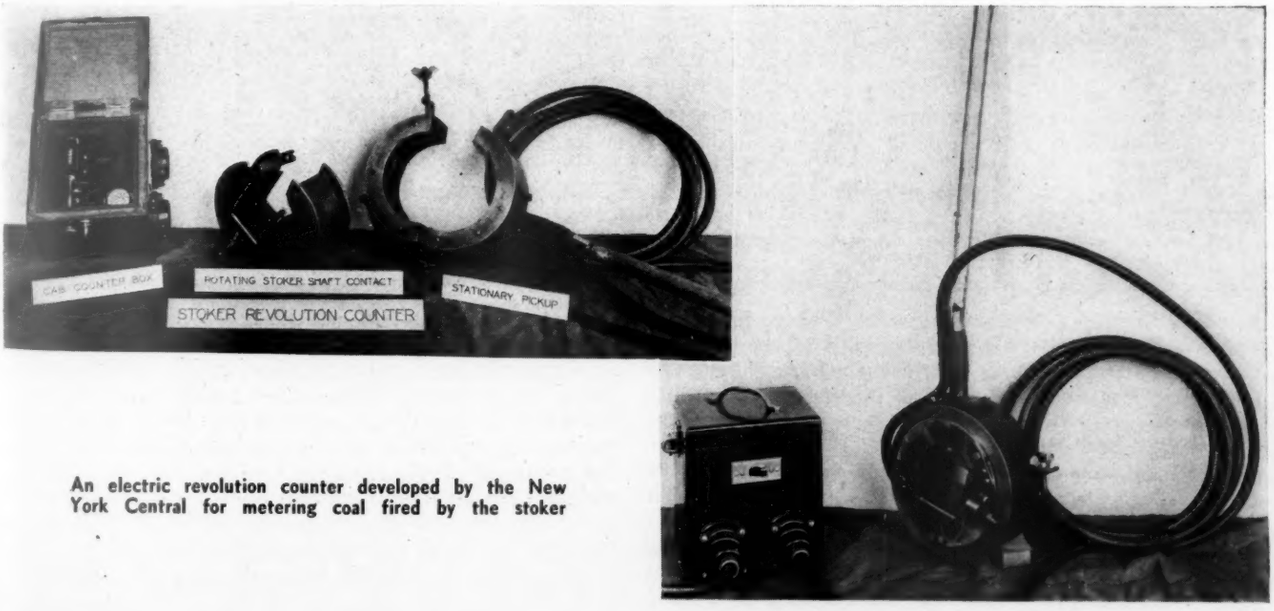
Most of the discussion following the presentation of the report on coal-firing practice dealt with methods of firing-up locomotives at terminals. Two methods were described. The first was the level method in which the grates are covered with about one scoop of coal per square foot, carefully leveled, covered evenly with shavings, and lighted all over the surface. The fire door is then left on the latch until steam pressure has been raised.

Practice on the New York Central at Chicago where smoke restrictions are severe is quite different. At this terminal the level method caused frequent smoke violations. The terminal dispatches about 100 locomotives per day from a small house. The present practice is to put in from 140 to 200 scoops of coal (an average of between two and three scoops per square foot of grate), throwing it against the side sheets, working from the front end back and gradually building heavier side banks toward the rear. Enough coal rolls to the center of the grate to serve for firing-up. A bundle of wood is placed in the center of the grate near the front end and lighted with waste. The banks are then gradually ignited on top, burning from the top down. As light a blower as possible is used. By this method it is said that the fire can be held for 24 hours or more without smoke violations.

This method of firing-up was also said to have improved road operation. Although after burning for some time the fire looks dirty because of the ash on top, it is said to produce no clinkers and to reduce the total amount of coal used.

To avoid segregation of lumps and fines the practice on the Wabash is to start loading the tender at the front end. The lumps then tend to roll toward the back of the coal space. As the coal is used the lumps then tend to roll forward and a fairly uniform mixture is maintained.

The Baltimore & Ohio and the New York Central have both employed on some of their locomotives revolution counters on the stoker (calibrated in pounds of coal per revolution of the engine) which have been used to educate and stimulate the interest of the firemen in



An electric revolution counter developed by the New York Central for metering coal fired by the stoker

their performance, and as an accurate method of determining fuel consumption during road tests where the fuel preparation is fairly uniform.

Slides were shown of the New York Central instrument which is an electric revolution counter, taking power from the 32-volt locomotive lighting circuit. The counter contacts can be readily and quickly attached to the stoker-engine shaft, and the indicator placed in the cab. Several of these instruments are employed by the fuel department. The coal delivered to the firebox by the stoker screw was accurately determined by weighing coal into the stoker hopper both on road and stationary tests and was found to be about ¼ pound per revolution of the stoker-engine shaft. The amount delivered varies somewhat with the amount of slack, a greater weight of coal being delivered per revolution as the slack increases. When the amount of slack is known or is carefully estimated the weight of coal delivered to the firebox can be obtained with an error not to exceed 5 per cent.

The Baltimore & Ohio has two types. One, applied to the Duplex stoker, consists of a counter of the usual type located in the cab, actuated by a connection to a tripper on the driving rack so that it counts the power strokes of the stoker engine. The calibration of this application indicated an average of 7½ lb. of coal per stroke. Another type, applied to the HT stokers, consists of a flexible shaft drive from the fly wheel of the stoker engine to a speed-recorder instrument located in the cab. The length of the tape used on a run indicates the amount of coal used according to the calibration of the installation which has averaged about 2,000 lb. of coal per inch of tape.

Steam-Turbine and Condensing Locomotives

Progress in installations—Weight ratios of high-speed trains

The four non-condensing steam turbine powered locomotives with direct mechanical transmissions, three in Sweden, and one in England, are, we believe, the only ones in actual service. Germany and France, however, have several designs under consideration.

In this country, the design and construction of a 5,000-h.p. two-unit steam-turbine locomotive with electric transmission, which was ordered in August, 1936, is nearing completion and it has been reported that it will be ready for service in a short time.

During the last few years, several different types of motive power have been built and placed in operation, handling high-speed passenger trains. There is considerable difference in the relative weights of these motive power units and the trains which they are handling. The following tabulation gives general information regarding such motive power units pulling a few of the comparatively high speed trains:

Modern High-Speed Passenger Trains

Railroad	Locomotives: Type	No. Units	Wheel arrangement	Length, ft.	Hp.	Weight, lb.*	Lb. per hp.	Cars: No.	Avg. weight, lb.	Total weight, lb.	Train weight, lb.	Weight of locomotive ÷ weight of train, per cent	Weight of train, lb. ÷ hp. of locomotive
A	Diesel	1	4-4	60	1,800	166,000	138	6	65,000	390,000	596,000	27.8	496
B	Diesel	2	4-4+4-4	120	2,100	370,000	176	9	71,000	639,000	1,009,000	36.7	481
C	Diesel	2	4-4+4-4	133	2,400	429,000	179	10	50,000	900,000	1,329,000	32.3	554
D	Diesel	2	4-4+4-4	132	2,400	438,000	182	11	77,000	847,000	1,285,000	34.2	535
E	Diesel	3**	6-6+6-6+6-6	210	5,400	883,000	164	14	119,000	1,666,000	2,549,000	34.6	472
F	Diesel	3**	6-6+6-6+6-6	210	5,400	878,000	162	14	117,000	1,638,000	2,516,000	34.9	466
G	Diesel	1	4-4	58	1,800	223,000	124	6	73,000	438,000	661,000	33.7	367
H	Diesel	2	4-4+4-4	141	3,600	587,000	160	9	120,000	1,080,000	1,667,000	35.2	463
I	Diesel	2	4-4+4-4	112	3,000	426,000	142	10	83,100	831,000	1,257,000	33.9	419
J	Steam	1	4-6-2	89	3,100	592,000	191	8	152,000	1,216,000	1,808,000	32.7	583
K	Steam	1	4-4-2	90	2,400	528,000	250	9	97,500	877,500	1,405,500	37.6	586
L	Steam	1	4-6-2	80	2,800	609,000	218	7	128,000	896,000	1,505,000	40.5	430
M	Steam	1	4-8-4	107	4,000	822,000	205	12	101,000	1,212,000	2,034,000	40.4	509
N	Steam	1	4-6-4	96	3,500	674,000	187	16	132,000	2,112,000	2,786,000	24.2	796
O	Steam	1	4-6-2	83	3,200	522,000	163	9	130,000	1,170,000	1,692,000	30.9	529
P	Steam	1	4-6-4	102	4,500	772,000	172	16	135,000	2,160,000	2,932,000	26.3	652
Q	Steam	1†	6-4-4-6	122	6,000	1,050,000	175	18	130,000	2,340,000	3,390,000	31.0	565
R	Steam-turbo elec.	2†	4-6-6-4+4-6-6-4	182	5,000	1,060,000	210	16	135,000	2,160,000	3,220,000	32.9	644

* Includes weight of tender for steam locomotives.
** Does not include auxiliary power equipment, carried in first car back of the three power units.
† Not yet in service, train consist assumed.

This tabulation covers 18 different trains, locomotives and cars for railroads listed as A, B, C, D, etc., of which the first 16 are in regular service.

During the last few years, the design of passenger cars has passed through a cycle from very heavy to extremely light construction and now has settled back to a conservative practical and medium weight construction which provides not only comfort but also safety. Modern passenger cars weigh, in round figures, about two-thirds the weight of older equipment.

The design and construction of motive power apparently has not undergone a change to reduce weight in proportion to what has been done for passenger cars.

Many refinements in design of locomotives have taken place and the efficiency and power per unit of weight have been greatly increased. The general trend, however, has been to increase the number of units per locomotive, the length, weight, number of pairs of wheels and axles, and other parts, all of which increases first cost, and operating and maintenance costs.

These tabulated comparisons of motive power equipment are presented with the hope that the locomotive designers and builders will sharpen their pencils and make greater effort to produce designs which will reduce the number of units, number of wheels and axles, length weight, multiplicity of electrical devices and complications to a minimum. When this is done, it will greatly reduce the first cost, fuel, oil, operating and maintenance costs.

The report was signed by L. P. Michael, Chairman, C. & N. W.

Oil-Firing Practice

Committee seeks to formulate recommended practice for cracked, heavy and blended fuels

For several years this committee has discussed various phases of the effect of cracked, heavy and blended fuels on locomotive firing practice. It was thought that this year's report might put in more definite form recommended practices. However, apparently due to the wide range in quality and character of the heavy fuel oils, it seems too early to accomplish this.

If the oil-burning men, whether or not you are on this committee, will submit definite recommended practices, it may be possible to place a more detailed report in shape for next year. There are many problems involved, such as:

1—Are cracked and heavy fuels now used by all oil-burning roads?

2—Is it possible to obtain the same quality of fuel for all divisions of a railroad so that the same instructions will apply everywhere?

3—Does the quality—chemical or physical characteristics—vary frequently, making it necessary continually to change instructions?

4—Is the best firing fuel temperature fairly well standardized, or does it vary due to quality of fuel, the season, etc.

The report is signed by R. S. Twogood, Sou. Pac., Chairman; L. E. Dix, T. & P.; G. L. Schneider, St. L.-S.F.; S. R. Tilbury, A.T.&S.F., and K. W. Muhl, West. Pac.

Discussion

A great part of the discussion was devoted to methods of heating the oil in tank cars preparatory to unloading and in the locomotive fuel tank, and the problem of water in the oil arising from the use of the open-jet method of heating.

The Santa Fe has equipped its oil tank cars with coil heaters. Prior to this the water in the oil ran from 5 to 15 per cent, with as much as 20 per cent in the tender tank. It was said that locomotives will steam with as much as 30 per cent water if an open jet is employed in the fuel tank to keep the oil and water sufficiently agitated. Nevertheless, the discussion indicated that where it is present, it is a potential source of delay.

Two other suggestions were made for the elimination of water from the oil preparatory to unloading. One was to place the oil cars in a heated building several days prior to unloading and thus avoid the necessity of applying heat directly in the car. The other was to draw the oil from a point slightly above the bottom of the storage tank and drain off the water as it settled to the bottom.

On the St. Louis-San Francisco, as oil has become heavier with the progressive development of cracking in the refinery, changes have been made in the oil pan and burner arrangement. More air has been admitted around the burner and the oil is kept at 180 deg. On the Santa Fe the draft pans have been lengthened from 50 to 70 in. and air admitted through the fire door under damper control. This is said to have reduced carbon deposits in the fire pan. The Santa Fe fireboxes are bricked on the back wall up to the door opening. No brick is applied on the other walls of the firebox.

The discussion indicated that exhaust-nozzle tips on oil-burning locomotives run from ¼ to ½ in. larger than those on similar coal-burning locomotives.

Supervisor of Fuel Conservation and Improved Railroad Operation

A free lance who tactfully coordinates activities and conditions in many departments

Because there is hardly a single detail of railroad operation that does not have some effect upon the utilization of the locomotive fuel and because practically every railroad employee in some phase or other of his activities contacts some of the details that are involved in the general problem of fuel economy and influences to some extent the degree of economy that is obtained in the utilization of the locomotive fuel, the supervisor of fuel conservation is properly a free lance officer and his authority and responsibility should extend into practically every branch of railroad operation and into contact with every group of railroad employees.

On any railroad where fuel conservation work is given the important status warranted by an intelligent appraisal of its value, it will be found that the supervisor of fuel conservation, by whatever local title he may be known, is tacitly endowed with such responsibility and expected to assume—tactfully of course—such authority, whether or not his instructions specifically so state.

It is generally recognized that over the period of the past 25 or 30 years the remarkable improvement in the economy with which locomotive fuel is utilized has been accompanied by and greatly influenced by the remarkable parallel improvement in practically every other phase of railroad operation. No one phase can for long remain out of step with the improvements effected in other phases—they are all more or less definitely geared together, motive power, car equipment, roadway, track, signals, maintenance of equipment, maintenance of way and methods of conducting transportation. Improvement in any one department helps all the others or forces them to improve. There will be little disagreement with the viewpoint that the best possible fuel performance on any railroad will go along with the best possible job of railroad operation in all its phases.

The supervisor should give special attention on his districts to the operating conditions of the locomotives in service on his territory to eliminate any waste of fuel and engine failures. In order to know these conditions, check must be made of condition of power at engine-house and performance on the road. It is correction of defective conditions before fuel losses and engine failures occur that will improve transportation service and reduce the transportation expense in many directions.

The supervisor of fuel conservation can exercise a

most potent influence for improvement in railroad operation by consistent missionary work with the engine terminal employees, the hostlers, the engine watchmen, the fire cleaners, the fire builders, the flue cleaners, the boilermakers, the machinists, their helpers and the supervising officers who direct them. The individual employee in each of the various classifications can affect the final result in proportion to the care and skill with which he does the job to which he is assigned, and the thoroughness with which he carries out the standard practices which have been established to direct his activities.

One of the most important features of engine-terminal operation is the thorough cleaning of flues in the locomotives dispatched. It has been determined from tests conducted for the purpose that the plugging of five superheater flues will increase the coal consumption five per cent, and the plugging of 25 small flues will increase the coal consumption to an equal extent for the same steam production by the locomotive. Dispatching locomotives with all flues clean will therefore save 10 per cent of coal as compared with locomotives permitted to run with this small number of flues plugged.

It is clearly within the province of his responsibility and authority for the supervisor of fuel conservation to emphasize repeatedly to the supervising officers of the engine terminals that, in the interest of fuel economy and good railroad operation, locomotives should not be dispatched until it is a reasonable certainty

(a) that the injectors will operate through the proper range to allow continuous boiler feeding and not make it necessary alternately to over-feed, then shut off.

(b) that the stoker is in proper adjustment to feed coal steadily and allow good distribution of the coal without the use of excessive jet pressure or excessive steam consumption by the stoker engine.

(c) that the grates are clean of clinker and will latch level and not rattle enough to loosen the fire or require the carrying of an excessively heavy fire.

(d) that the brick arch is full length specified for the firebox and tight and clean.

(e) that the superheater units are tight at the header.

(f) that the smoke box is tight against air leakage and the draft appliances in correct adjustment.

(g) that the power reverse will stay put as set and not "creep."

(h) that the valve gear is in good adjustment for economical steam distribution.

(i) that valve packing and piston packing is tight against "blows."

(j) that the air-pump is operating efficiently.

(k) that the lubrication appliances are functioning properly.

(l) that the tender is supplied with the most suitable grade of the coal available on the tipple for the service to be performed by the locomotive.

Another important field for the supervisor of fuel conservation's special attention consists in close and constant check on the utilization of locomotives in service on his territory, with the object of keeping in service only the minimum number necessary to handle the business, by storing every engine not definitely needed, thereby reducing as much as practicable the supplementary locomotive mileage, resulting from excessive running of double-headers and light engines, all of which not only consumes extra fuel, but also increases maintenance, engine-terminal and other transportation expenses. Where longer locomotive runs can be arranged or there are opportunities to turn engines back without terminal attention, it would bring about a more economical operating cost. Upon every possible occasion suggestions should be made to the superintendents for increasing engine load and reducing excessive running speed in every case where schedules will permit. Unnecessarily high speed results in excessive maintenance costs as well as high fuel consumption, particularly with locomotives not designed for the high speed running.

Among the many details that profitably engage the attention of the supervisor of fuel conservation are the constant following up of road delays due to hot boxes, defective draft gear, rough handling, faulty air-brake equipment and air-brake handling, slow orders, proper handling of blow-off cocks to keep water concentration where engine will lubricate most efficiently, delays in taking coal and water. In order to avoid delay in taking water many roads today with larger power have tanks of 17,000 to 22,000 gallons, which have reduced expense of upkeep to equipment due to less frequent stopping with heavy tonnage trains.

The supervisor of fuel conservation can make an important contribution to the improvement of railroad operation by making regular periodical close checks of delays to locomotives in terminals, both in enginehouse territory and in transportation yards, which affect the utilization of the locomotives, the number required in service and expenses of operation in addition to the fuel expense. In order to reduce these delays the enginehouse forces must know that proper supplies, such as fuel, water, lubrication and proper tools have been provided for the engine crew so they can leave enginehouse on the time called for.

Because of the general nature of his interest in the operation of his railroad the supervisor of fuel conservation is in position frequently to make suggestions to the superintendents of methods by which the various departments may coordinate activities to improve the general operation. In train yards there should be no delay waiting for trains. Yardmasters should have close line-up on train arrivals and amount of switching required so that closer figure can be given as to when yards will require power, thereby eliminating terminal delay.

A division superintendent is presented with no better opportunity to influence a substantial saving in cost of operation than through giving his personal supervision to the feature of cooperation between his dispatchers and yardmasters on the one hand, and his roundhouse foremen on the other hand in the matter of calling time and dispatching time for freight locomotives. The average freight locomotive uses 400 to 500 lb. of coal per hour standing under steam in terminal. Careful calling of power and adequate organization for preparing locomotives for the crews when and as needed are necessary in order to avoid very heavy waste of coal between the time of firing up and the time of leaving the engine terminal. An average of ten engines per day fired up an hour earlier than necessary will waste enough coal to pay the additional firebuilder whose services might be necessary during the busy dispatching period of the day, to make it practicable to avoid this waste of coal, and in such a case the railroad money would be used to employ a railroad man instead of going to a coal miner.

By reason of the nature of his activities and contacts with the details of the railroad operation the supervisor of fuel conservation is in particularly good position to influence reduction in delays due to poor dispatching, such as running freight trains on the time when superior trains must be cleared, also excessive delay in meeting trains which bring about not only terminal delay, but delay enroute, and where excessive delays occur and the delays must be made up, it results in increased fuel consumption per 1,000 gross ton-miles.

The supervisor of fuel conservation should also ob-

tain and pass on suggestions of engine crews and train crews for improvement in operating methods. When supervisors contact engine and train crews about the terminal or out on the line many good suggestions of improvements have been brought out. When good constructive suggestions have been brought up, members of the crew should be given credit for their interest, which will bring about greater interest upon their part to have poor practices corrected.

Another very fruitful field for the activities of the supervisor of fuel conservation on coal-burning railroads, and one which is not generally given the attention it deserves, falls under the general heading of systematic supervision over the preparation, segregation, and utilization of locomotive coal. The experience of many railroads has demonstrated that not only have they saved considerable fuel, but they have greatly aided in the general train and locomotive performance by following such a policy.

The report was signed by G. E. Anderson, Great Northern; P. E. Buettell, C. M. St. P. & P., and A. A. Raymond, N. Y. C.

Discussion

The results of New York Central standing tests on various preparations of egg and slack coal, in which the percentage of slack was varied, showed that the consumption increased with the increase in the percentage of slack. The results of these tests form a basis for determining the most economical mixture from the standpoint of over-all cost. In answer to questions concerning the standing tests, it was developed that a water spray is introduced into the cylinders when these tests are under way in order to de-superheat the steam and produce a condition at the exhaust similar to that made in regular service. This increases the volume of steam and, through a large pipe connected to both exhaust passages, an amount of steam is bled off equal to the amount of water introduced.

As a result of the tests the capacity of locomotives which seemed to have been exceeded under the speed-up of schedules during the past few years has been increased until the performance of these locomotives is still equal to the demand. The exhaust-nozzle diameter was increased from 6¾ in. to 7 in.

Reference was made to the value of the Loco Valve Pilot as an aid to the engineman in getting full performance from the locomotive. Inspections of the tape records from this instrument are said to show a surprising degree of uniformity in performance. With this instrument, it was pointed out, the engineman is not dependent upon the sound of the exhaust as a guide to his performance and does not have to learn the sound of the locomotive all over again following a change in the front end.

A considerable part of the discussion following the presentation of this report dealt with the preparation of coal at the mine. The need of attention to keep impurities in mechanically loaded coal down to a satisfactory point was stressed. An objective of 750 lb. of foreign matter per car was suggested in this connection. Coal loaded with loading machines in the mine frequently runs as high as 1,700 to 1,800 lb. of foreign matter per car. The value of washers in reducing ash from as high as 15 to 20 per cent down to 10 per cent was also mentioned. The disadvantage of the washed coal, however, lies in its higher moisture content which prevents it from running well in the chutes. To overcome this the installation of a coal laundry at an Illinois mine was cited where the coal is dried following washing so that the moisture of the coal leaving the plant is below that of the coal in the seam itself.

Utilization of Locomotives

Main line coaling stations a factor in increasing length of runs

The service from our locomotives, under adverse business conditions, on the thirteen largest railroad systems in the country for June of this year is shown in the table.

Locomotive-Miles per Active Locomotive Day

Road	Miles per active locomotive per day		
	Passenger	Freight	Switch
Atchison, Topeka & Santa Fe	271.3	129.4	66.4
Atlantic Coast Line	140.1	75.4	41.7
Baltimore & Ohio	214.2	102.8	65.2
Chicago & North Western	158.8	97.7	55.0
Chicago, Burlington & Quincy	187.0	97.1	56.5
Chicago, Milwaukee, St. Paul & Pacific	182.1	97.0	68.3
Chicago, Rock Island & Pacific (includ. C. R. I. & G.)	189.4	110.0	63.2
Illinois Central (includ. Y. & M. V.)	127.8	73.8	50.1
New York Central	224.7	123.3	74.9
Pennsylvania R.R.	200.5	108.1	76.9
Southern	156.9	78.2	41.7
Southern Pacific Co.	213.4	106.8	69.5
Union Pacific R.R.	268.5	101.7	69.6
Districts:			
Eastern	172.9	102.4	68.4
Pocahontas Region	153.2	86.1	65.5
Southern Region	148.0	85.7	49.3
Western	194.7	100.9	60.9
United States	176.7	97.9	62.5

In passenger service the highest mileage per active locomotive day was obtained on the Santa Fe—271 miles. Perhaps a fair speed in passenger service for the country as a whole can be accepted as 35 miles per hour, so that 271 miles represents 7¾ hours service per day. In freight service the highest again is the Santa Fe—129 miles per active locomotive day. Our last full year's statistical reports indicate a freight-train speed of approximately 16 miles per hour so that, dividing the 129 miles by 16, we find that the freight engines are working approximately eight hours a day. In switch service the highest mileage is obtained by the Pennsylvania System—77 miles per active locomotive day—and this is based on six miles per hour, so that it represents nearly 13 hours' service.

Road locomotives working approximately eight hours a day and yard engines thirteen hours a day is being accomplished by only a few systems. It is, therefore, not necessary to discuss how we could get an average of twelve hours a day from our road engines and sixteen from our switch, but rather to discuss whether it is possible to obtain eight hours a day from the road engines and thirteen from the switch. Thus, theoretical figures are not being discussed, but figures obtained in every-day practical operations on large systems.

What Interferes with Improvement?

What interferes or prevents road engines, in general, from working eight hours a day and what interferes with

switch engines, in general, working thirteen hours a day? Perhaps the reasons come under some one of the following headings:

1—End of the road (or train does not go any further).
2—Because of necessary switching the train will be held in the yard for three or more hours.
3—Two trains are combined so there is a surplus of one locomotive.
4—The train goes to a division using a different class of power.
5—The ash pan is full.
6—All the available water has been used out of the tender cistern.
7—The coal has all been used.

These are days of fast schedules. Trains cannot be held at stations a long time while locomotives go to the coal dock for another tender load of coal, so if there is no coaling facility on the main line it means that an extra locomotive must be provided, fully coaled, so that the train can move forward promptly.

Changing Engines Makes Coal More Expensive

Changing locomotives, of course, loses the time of the locomotive taken off. Considering a typical 24-hour day, the average loss of time is perhaps five hours before this engine is coaled and returned. Suppose that a passenger train averaging about 60 miles per hour burns, perhaps, three tons an hour so that after nine hours' work it is necessary to take the engine off to get 27 tons on the tank and that, in obtaining the 27 tons, the engine is out of service approximately five hours; that is, for every nine hours the engine works it is idle five hours, or it is working 64 per cent of the time. This, carried through, would indicate that it takes 1⅓ locomotives to do the work of one engine and that this is because it needed a tank of coal.

Let us suppose that coal is worth $2 at the mine and it costs about $1 more to get it from the mine onto the locomotive, or an average cost of $3 a ton for the 27 tons, or $81. To this $81, however, must be added the cost of fuel used in going to and from the enginehouse, cleaning or dumping the fire, perhaps the extra cost of handling a locomotive through a large enginehouse organization if no repairs are needed, and the value of a locomotive for five hours at at least $1 an hour, so that we have:

$81 for coal
3 for coal burned to and from the enginehouse, cleaning and dumping the fire
5 for extra enginehouse cost
5 for the value of the engine while out of service

$94 total

Divided by the 27 tons, this gives approximately $3.50 a ton; that is, 16 per cent increase in the cost of coal, because the coal wasn't handy.

In freight service the picture is the same. A locomotive, making perhaps 40 miles per hour and using perhaps four tons of coal each hour on a division run of 150 miles, would then use 15 tons—some left but not enough to make the next terminal. On a symbol freight, with the coal dock at the enginehouse out of the way of the yard, for prompt handling of the train it is advisable to supply another locomotive.

In this case $45 worth of coal and similar expenses for coal to and from the enginehouse, regular enginehouse expense and five hours out of service for the locomotive makes a total of $58 for 15 tons, or a little over $3.85 a ton—another increase of 28 per cent in the cost of fuel because the coal wasn't handy.

Switching locomotives are working 16 to 24 hours in many yards, but these engines burn very few tons of coal in a 24-hour period. Hence, if coal were available and the fire maintained in reasonably good condition, it is only necessary to clean the fire after extended intervals where there is a possibility of working the locomotives for 24 hours. Of course, there are many yards where there are only a few 24-hour jobs available. Suppose a locomotive needs six tons of coal and, again, that the facilities are not handy. [The ash pit and coal dock should be part of the general yardmaster's and chief car inspector's office.]

The six tons of coal cost, perhaps, $18, made up of $3 for the ton of coal used while the engine is out of service, $2 for enginehouse expense and $7 for the time the engine is idle before she can be returned, or $30, an average of $5 a ton. This is an increase of 66 per cent in the price of coal because of the fact that the facilities were not handy.

Convenient Coal Chutes Keep Locomotives at Work

Many roads have ash, coal and water facilities for freight and switch power handy so that, for instance, if a symbol freight train comes into a yard and a few of the cars require icing, etc., the engine can be run to a handy pit where the fire will be cleaned, the engine will be coaled, take a tank of water without moving and necessary inspection can be made so that by the time the train is iced and the cars are being shoved down into the yard the engine can couple on and start pumping the air. This, perhaps, can be a spur off the ladder with an inexpensive coal-handling plant such as we see in all of our local coal yards. One can be obtained that will deliver two tons a minute at almost infinitesimal expense when the cost of it is compared to the cost of using another locomotive. In the case of a freight locomotive there is a bonus of $8 to $13 for every locomotive handled in this way.

In the case of a switching locomotive there was one yard where it was possible to put one of these small coal facilities on an unused spur track. The yard crew during their lunch period set the engine on the track over the ash pit and when they finished lunch she had coal, water, fire cleaned, and was ready to go back to work, with a bonus of perhaps $10 for every engine handled in that way. Of course, if any of these engines are found to need roundhouse repairs, they are immediately sent to the house.

The proceedings of all mechanical department meetings would seem to establish the fact that substantial economy results from long locomotive runs, because fewer engines are needed, fewer housing facilities required, and because the fuel used in enginehouse territory is saved. The reliability of modern locomotives has been proved on many through runs, and high individual locomotive mileages are a matter of record. The question, then, would seem to be why don't a majority of the locomotives run through and why is the mileage per locomotive day, as reported by the Bureau of Railway Economics, so low?

The report was signed by A. A. Raymond, chairman of the Committee on Utilization of Locomotives.

Discussion

Attention was directed at the limitations on the average miles per active locomotive day as a basis of rating the utilization of locomotives on various railroads. Unless the relation between branch-line miles and branch-line train-miles to main-line miles and main-line train-miles are known, the comparisons are sure to be deceptive. Consideration must also be given to the fact that increasing train speeds are reducing locomotive-hours on the road and increasing the proportion of total hours spent in the engine terminal.

The Atchison, Topeka & Santa Fe has been particularly successful in developing long passenger locomotive runs.

For these runs oil is used for fuel over the entire line. The runs are between Chicago and La Junta, Colo., a distance of 992 miles, and between La Junta and Los Angeles, Calif., a distance of 1,235 miles. The tenders carry 20,000 gallons of water and 7,000 gallons of fuel oil. Fuel is taken twice between terminals on each of the runs. The use of Foam-Meters on the passenger locomotives was mentioned particularly as a factor in improving conditions on these runs. Where formerly the locomotive required a water change at one end of the run and a washout at the other, it has now become possible to run the locomotive a full 30 days between washouts. The Foam-Meters are now being installed on freight locomotives.

It was reported that the Santa Fe is now getting 18,000 miles per month on long-run assignments, but has set 20,000 miles per month as the goal.

In connection with the high average miles per active locomotive day it was pointed out that the Santa Fe has fewer branch-line miles than the average, so that the long main-line runs have a relatively larger influence on the statistical average than is the case on many other large systems.

One of the factors which tend to reduce the average miles per month on locomotive assignments is too large a supply of active locomotives. Where some locomotives run from 14,000 to 16,000 miles, it was pointed out that most of the locomotives would not exceed 6,000 miles per month. This condition can only be overcome by a definite assignment of locomotives to regular runs and insistence that they be kept on those runs.

The problem arising from a supply of a variety of coals on long locomotive runs in coal-burning territory came in for lively discussion. The practice of keeping a locomotive on a run where it comes into the terminal with a clinkering coal and will continue with a better grade of fuel was questioned from the standpoint of fuel economy. One speaker estimated that from one to two tons less of the good coal would be burned if a locomotive with a fresh fire were placed on the run instead of the incoming locomotive. On the other hand, the experience of both the Alton and the Frisco was cited on long runs in which the locomotives burned four grades and qualities of fuel, some having ash of relatively low fusing point, without the necessity of cleaning the fire. Where such practice prevails attention was called to the need of drafting the locomotive to suit the fuel requiring the sharpest draft. To prevent clinkering of the fire when burning coal having ash with a low fusing point, it is the practice on the Alton to open the blower before the throttle is closed. This prevents a back draft of hot gases from the fuel bed through the ash, which is one of the causes of clinkering. While it was not maintained that this practice might not burn more coal on the road than would be the case where but one kind were burned on a single locomotive, the locomotives are said to burn less total fuel in continuous service than would be the case if they were held at intermediate terminals.

Archaic Details in Locomotive Design

Pointed questions concerning conventional features which affect fuel economy

By F. P. Roesch

Vice-president, Standard Stoker Company

The past few years has witnessed a decided change in operating conditions. Speed and more speed is now the watchword, and this means not only speed between terminals but reduced delays at such points. We can no longer tolerate the delays incidental to cutting the engine off, backing it down to the cinder pit to clean the fire, etc., where crews are changed. On the contrary, the fireman is expected to keep the fire in such condition that, when arriving at the change point no further attention is required. This calls for a 100 per cent job of firing, without fire cleaning, regardless of the length of engine run. It can be done when conditions are right.

Clinkers and Banks

In many quarters the impression still prevails that the formation of clinkers in a locomotive firebox is due altogether to the character of the coal or the manner in which it is fired, or both. That theory still holds good where locomotives are manually fired, but where mechanically fired under conditions suitable to mechanical firing, can be thrown into the discard.

The above statement may be challenged on the grounds that any coal producing an ash of a low temperature fusing point will also produce clinkers. We do not dispute that statement, but do maintain that more clinkers are caused through improper fire conditions, viz., uneven thickness, etc., than are directly due to fuel characteristics. Often these conditions are due to correctable factors over which the fireman has no control. It is our job to correct such conditions as far as we can. As we cannot change the characteristics of the fuel, and as the fireman is doing the best he can under the circumstances, we must attack the problem from the mechanical angle and recommend such construction changes as will tend to reduce, or if possible eliminate these bad fire conditions.

This points directly to a correctable construction that is one of the primary causes of clinkered fires where the coal is inclined to clinker, or to conditions equally responsible for fuel waste with what is termed "good" or non-clinkering coal. The results are practically the same from a combustion standpoint, regardless of whether the inflow of air through the fire is restricted by clinkers or a heavy bank, as we only get surface combustion at such points and the remainder of the grate area must carry the full load. This results in a higher than the economical rate per square foot of grate over the remaining or effective area, with the usual attendant fuel loss.

Sloping Grates

When trailer trucks with inside journals were first introduced, it was necessary to elevate the rear end of the mud or foundation ring in order to provide clearance for springs and spring rigging. This construction resulted in a grate having a pronounced downward slope from the rear to the throat sheet. While this construction offered no serious impediment to good firing when locomotives were operated at medium speeds, it does materially affect fire conditions today, as the excessive oscillation of the locomotive at speed, results in the fire bed creeping forward—creating a heavy fire at the forward end of the firebox and a thin fire at the rear. This condition prevents the admission of sufficient air in front to support combustion, and admits too much at the rear,

thereby in effect restricting the effective grate area proportionate to the amount covered by the heavy fire. The inside-journal trailer truck is largely a thing of the past, but the sloping grate is still with us. Why?

While on the subject of sloping grates, we may as well consider what are termed "hog trough" or "basket grates," some of which are still in service. These grates slope from the sides to the center, forming what might be termed a longitudinal trough or basket, with sides higher than the center.

When we were first taught the art of firing we were instructed to fire along the sides and also keep the corners, particularly the back corners, full, i.e., keep the fire heavier along the sides and in the back corners; this to avoid the inrush of cold air at these points. Obviously, with the hog trough type of grate this is quite a task and usually results in a gradual increase in fire bed thickness through the center, creating a condition not conducive to good combustion. Therefore, we believe we can consistently recommended the leveling up of such grates where they occur, especially where locomotives are mechanically fired. The improved overall combustion, with the attendant reduction in fuel consumption, will more than offset the expense of the change.

Sloping Backheads

The majority of locomotive mechanical stokers fire through the door opening or through holes piercing the boilerhead at about the level of the firedoor opening. In order to obtain proper distribution, it is necessary to extend the distributing plate from six to eight inches beyond the door sheet. Where the slope of the back boilerhead is excessive, it is necessary to propel enough coal backward to cover an area equal to the distance from a vertical line from the end of the distributing plate to the door sheet at the grate level, multiplied by the width of the firebox. This area may be from four to six square feet. As projecting coal backward mechanically presents certain difficulties, the area mentioned above is frequently covered by "dead grates," thus reducing the effective grate area by that amount. Why an excessive backhead slope?

The demand on a locomotive boiler is not constant, but varies from full load to no load. Therefore, we cannot set up a definite ratio as between steam requirements and grate area. The best we can do is to arrive at some compromise that will result in a fairly low rate per hour at light or no load, but not an excessively high rate at maximum demands, as either results in fuel waste. The result of such compromise may be a combustion rate varying from say 30 lb. at low demands to 150 lb. or more per sq. ft. of grate per hour at maximum requirements.

Haslam and Russell, in "Fuels and Their Combustion," 1926, state that where the fire is loose and of a depth so that air can pass through it freely, all the oxygen in the air admitted has combined with the carbon in the fuel in the ratio of one atom of carbon and two of oxygen, producing CO_2, and that this combination is completed at from 4 to 4½ in. above the bottom of the fuel bed, except with lignite, where it is completed at from 2 to 2½ in.; the measurement in each instance beginning at the top of the ash bed. Quoting directly: "That portion of the fuel bed above the oxidation zone is a reducing zone where the CO_2 formed in the oxidation zone is partially reduced by the coke to CO. The thicker the fuel bed the more CO is formed. Since the object sought in the combustion of coal on a grate is to burn it with oxygen from the air, any reduction from CO_2 to CO is a step backwards. Consequently, the fuel bed should be no thicker than is necessary to prevent blow holes. Blow holes are caused by the unevenness in the distribution of coal on the grate or anything, such as clinkers, that produces uneven resistance to the passage of primary air up through the fuel bed."

As the heat value of CO_2 measured in B.t.u. is 14,500, while that of CO is but 4,500, it requires no slide rule to approximate the fuel or heat loss due to imperfect fire conditions.

Dead Grates

Consider now the effect of dead grates, with which we can also include dump grates. Haslam and Russell's experiments indicate that the fire bed must be kept relatively loose in order to obtain good combustion. Obviously this cannot be done on a dead or dump grate. We therefore have on the area taken up by such grates a condition practically the same as the one previously mentioned. And yet there are in service today locomotives where from 20 to 35 per cent of the total grate area is taken up by dead and dump grates. The reason given for this condition is that the coal fired is inclined to clinker, therefore the need for many and large dump grates to facilitate fire cleaning. The fact is entirely overlooked that dead and dump grates are conducive to clinker formation, from which we could logically conclude, less dump grates, less clinkers, and with less clinkers, less dump grates and less time for fire cleaning. Cannot this association take the position that the number and size of dead and dump grates can and should be reduced or entirely eliminated under present conditions?

Air Opening Through Grates

Of course, where locomotives are mechanically fired, all oversize lumps are mechanically reduced to proper firing size before introduced into the firebox. In this reduction, naturally more fines are created than originally contained in the coal. To guard against loss, both stack and ashpan, it became necessary to adapt the grates and draft to the size of the coal as fired, and where this was done logically, it was immediately observed that the results justified the cost.

The introduction of mechanical firing has done more to promote fuel economy than any one other appliance except the superheater, as it compelled the use of a logical grate. It is unnecessary to dwell on the grate of the past, viz., the finger type, except to say that this type of grate had perhaps a greater influence on fuel loss—at both ashpan and stack—than any other part of the locomotive, an influence that was not realized until the introduction of mechanical firing. To that design of grate can be charged directly the cinder loss, always until recently attributed to the size of the coal as fired. As all stokers must reduce oversize lumps of coal to sizes suitable for mechanical or steam jet distribution, and as in this reduction some small sizes are necessarily produced, the stoker manufacturers in self-defense had to prevail on the users of mechanical stokers to resort to a grate suitable to the coal as fired, and when this was done another old theory, viz., that stack loss is proportionate to the size of the coal fired, was exploded and can also be thrown into the discard.

Perhaps the credit for fuel reduction should be evenly divided between the stoker and the modern restricted grate. At any rate, the first compelled the adoption of the second, and the second saved the reputation of the first. However, regardless of which should have the credit, we can consistently recommend the adoption of the restricted grate and consign the finger type to the limbo of avoidable factors in locomotive design affecting fuel consumption.

While engaged in exploding old theories, we must not overlook the setting of the brick arch. The lower end of this arch was usually set about 5½ in. from the throat sheet, on the theory that such setting prevented the stoppage of the lower tubes with cinders. But when tests proved that the draft immediately under such opening was more than twice as high as over any other part of the grate area, and as a result of this high draft the finer particles of coal suspended in the draft current were whipped through this opening, through the lower tubes and so on out of the stack, that theory also went haywire and the arch was sealed against the sheet, so that now any fine particles of coal suspended in the draft, strike the arch, fall back on the fire bed and are consumed, instead of being discharged from the stack and lost. So the setting of the brick arch can also be listed among avoidable factors.

Heating Surface

Locomotive designers are beginning to give more thought toward decreasing the length of the boiler tubes and increasing the length of the combustion chamber—a step in the right direction. Dr. W. M. F. Goss upset the old theory of the relative value of firebox and tube heating surface at the Coatesville tests, but the lesson to be drawn from that test was not fully appreciated in all quarters. However, time marches on and leaves old theories behind. Aside from the difference in value of heating surface, it has been found that a better diffusion of draft over the grate area can be obtained where a combustion chamber is employed than without one. Not only that, but a more complete combustion of the gases is possible, and further, a possible reduction in cylinder back pressure due to less draft restriction and resultant lower front end vacuums required. So let us include long tubes and short or no combustion chambers among our avoidable factors.

Draft and Back Pressure

Many attempts have been made to reduce cylinder back-pressure, but so far without entirely satisfactory results, due primarily to failure to fully recognize the fact that the boiler output is dependent on the coal rate, and that this in turn is governed by the draft, and that with present nozzles of a fixed dimension we automatically obtain a firebox draft proportionate to the steam demand.

True, in starting or at low speed and long cut-off, the draft is excessive and indicates a possible advantage in a variable nozzle, but this when weighed against the disadvantage and the fact that in many cases the nozzle is not the dominating factor in the production of back pressure, prompts the consideration of other factors involved, such as restricted exhaust passages, etc.

Present cylinder design includes the valve chambers, cylinders and saddle in one integral casting. If now, instead of leading the exhausts from each cylinder through tortuous and sometimes restricted passages to the exhaust stand, all such passages were eliminated and the exhausts were conducted direct to the saddle chamber, we should gain a possible reduction in back pressure through reduced friction in exhaust passages, but also a reduced exhaust pressure and draft at low speeds and long cut-off through the expansion of the steam into an increased volume before its final discharge.

Such an arrangement holds further attractive possibilities, in that such a chamber would serve as a very effective by-pass, particularly if the exhaust from auxiliaries were also piped into this chamber, in which event the oil-saturated steam from these auxiliaries would serve as an effective lubricant for the valves and pistons while drifting, and so eliminate the use of a drifting valve or drifting throttle taking live steam directly from the boiler. The amount of steam used for drifting purposes has not been measured recently, but in tests conducted some years ago it was found necessary to employ a two-inch pipe from the boiler to the saddle in order to sufficiently dilute the gases drawn from the front end through the exhaust nozzle to prevent the carbonization of the oil and its deposit in the exhaust passages and on the pistons and valves.

Conclusions and Forecast

While the locomotive of today has incorporated one or more of the features mentioned, the high speed locomotive of tomorrow will have all of them, viz., a softer exhaust, a level restricted grate, a sealed extended arch, increased combustion volume compared to grate area. It will burn semi-pulverized coal, fired mechanically without fear of cinder loss and with much greater efficiency than under present methods, which means greater heat transfer and higher superheat. In other words, engineers will devote more study toward increasing combustion efficiency and in so doing, increase overall efficiency, as the one goes hand in hand with the other.

The locomotive will retain its present general outward appearance, and while the streamline effect will no doubt be retained for its advertising value, the boiler and particularly the firebox end and related parts, will witness the most detailed changes, as improvement in the generation of steam is a fertile field and one wherein we find the greatest promise at the least expense.

Discussion

Referring to Mr. Roesch's remarks concerning the sloping back head, it was suggested that it might even be desirable to pull the lower part of the back head inward to bring the back corners in front of the point from which the coal is distributed. The question was raised later, however, whether such a change might not lead to staybolt trouble much the same as that now experienced in the throat sheet.

The employment of large radii at the back corners of the firebox was cited as one means of overcoming some of the difficulty in the distribution of coal to the back corners of the firebox. This also was said to have improved the circulation on the boilers.

An attempt to replace sloping grates with level grates in existing motive power was cited in which the loss of heating surface and the reduced combustion space between the front end of the arch and the fire proved to be serious drawbacks. The use of plates to reduce the air opening at the rear of the grate has helped somewhat, but was said to have, in effect, reduced the grate area and the firebox capacity.

The front end came in for a considerable amount of comment during the discussion. Instances were cited where the refinement of the front end had increased the capacity of locomotives. The desirability of some form of variable exhaust was also referred to.

Several persons also referred to the need for a closer knowledge of locomotive capacity and just where the reverse lever should be placed under varying conditions to get the best performance.

Reference was made to the use of the Wagner drifting valve on the Santa Fe which serves to effect some reduction in the amount of braking required on long mountain grades.

International Railway General Foremen's Association officers suggest change in name of that organization

Problems of

Locomotive Maintenance

At the same time that the other mechanical associations were holding meetings in Chicago on Tuesday, September 27, the officers and executive committee of the International Railway General Foremen's Association discussed the future of that organization and made plans for a three-day meeting in 1939.

In reviewing the past work of the organization, as well as its present status, it was believed wise, in order not to interfere with other mechanical associations, to limit its activities to problems concerned with locomotive maintenance. The Mechanical Division, A. A. R., deals with standards and recommended practices of locomotive design and construction. The Railway Fuel and Traveling Engineers' Association concerns itself with problems relating to locomotive operation and fuel economy. The General Foremen's Association heretofore has always included car department subjects in its program, but it was felt that these should be left entirely to the Car Department Officers' Association.

In keeping with this new conception of its field, it was decided to recommend to the convention next year that the name of the International Railway General Foremen's Association be changed to the Locomotive Maintenance Officers' Association and that its membership include all officers and supervisors interested in locomotive maintenance. While this will limit the range of subjects to be considered, it will greatly intensify the work of the association and should bring into its membership important mechanical department officers, who up to this time have had no organization in which they could find a place to express themselves on the great variety of questions relating to locomotive maintenance in both the back shop and the enginehouse, including problems of administration as well as of practice.

Here, for instance, is a place for general mechanical staff officers interested in such problems—as an example, system supervisors of shop tools and machinery, apprentice supervisors, mechanical engineers and such of their assistants as may be specially interested in locomotive maintenance questions, representatives of the engineer of tests, etc. Obviously it will include general master mechanics and master mechanics who have a considerable interest in locomotive maintenance problems, shop engineers, shop superintendents, enginehouse foremen, chief locomotive inspectors, apprentice instructors and all shop foremen having a relation to locomotive maintenance, with the exception of those in the boiler shop, who have an association of their own.

F. B. Downey, President

It will be recalled that at a meeting of the Committee on Co-ordination of the Mechanical Associations, held in Chicago on July 25, the announcement was made that the American Railway Tool Foremen's Association would affiliate with the International Railway General Foremen's Association and that efforts would be made to revive the International Railway Master Blacksmiths' Association and to affiliate it with the General Foremen's Association. Pending final action in these respects, the

program for next year will include topics of special interest to these groups. There is always the possibility in the future that one or more separate sessions of the convention may be arranged for them if they indicate a sufficient interest. Obviously many problems of primary interest to these groups will also commend themselves to the other members and can profitably be given consideration by most of them.

Arrangements were also made for a special effort to build up the membership of the association during the year.

Next Year's Program

In planning for the three-day convention next year the following committee subjects were selected and assignments were made to the different officers to take immediate steps to secure the acceptance of men who were suggested as chairmen of the various committees, and to see that with the aid of these chairmen the committees will be organized and put to work as quickly as possible. The committee reports include:

(1) Scheduling locomotives through the shop for classified repairs; committee chairman, F. B. Downey, assistant shop superintendent, Chesapeake & Ohio, Huntington, W. Va.

(2) Training and coaching of supervision.

(3) Forging and heat treating of locomotive parts.

(4) Roundhouse problems caused by long runs and high speed, and the facilities for handling them.

(5) Best methods of selecting proper machinery and tools for repairs to modern locomotives.

(6) High spots in machine shop practices.

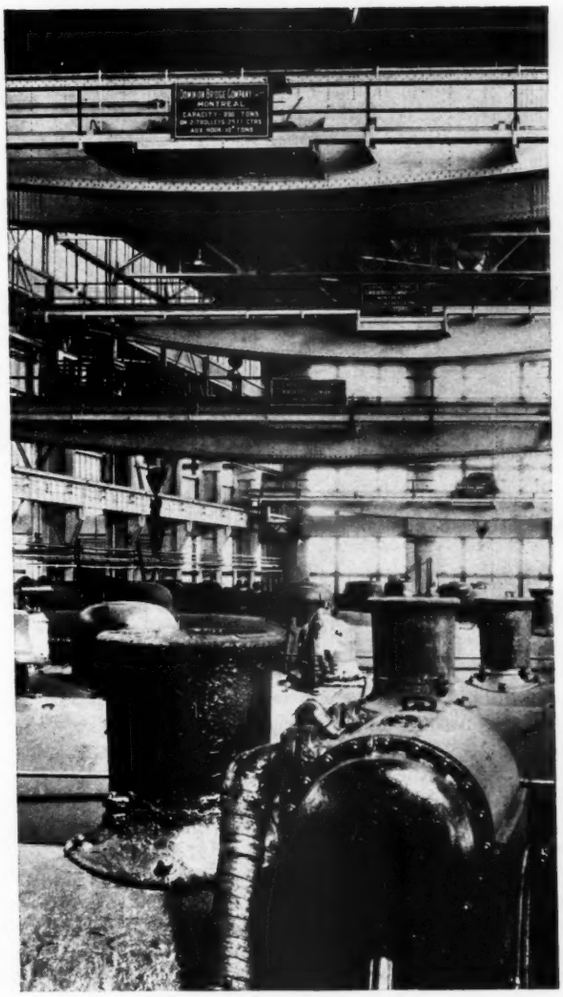
In addition to these reports it was decided to have two individual papers as follows:

(1) Proper maintenance of modern locomotives, by D. S. Ellis, chief mechanical officer of the Chesapeake & Ohio; New York, Chicago and St. Louis, and Pere Marquette.

(2) Training of apprentices.

Two addresses by executive and operating officials are also scheduled on the program as follows:

(1) Training of supervisors, by L. W. Baldwin, chief executive officer, Missouri Pacific Lines.

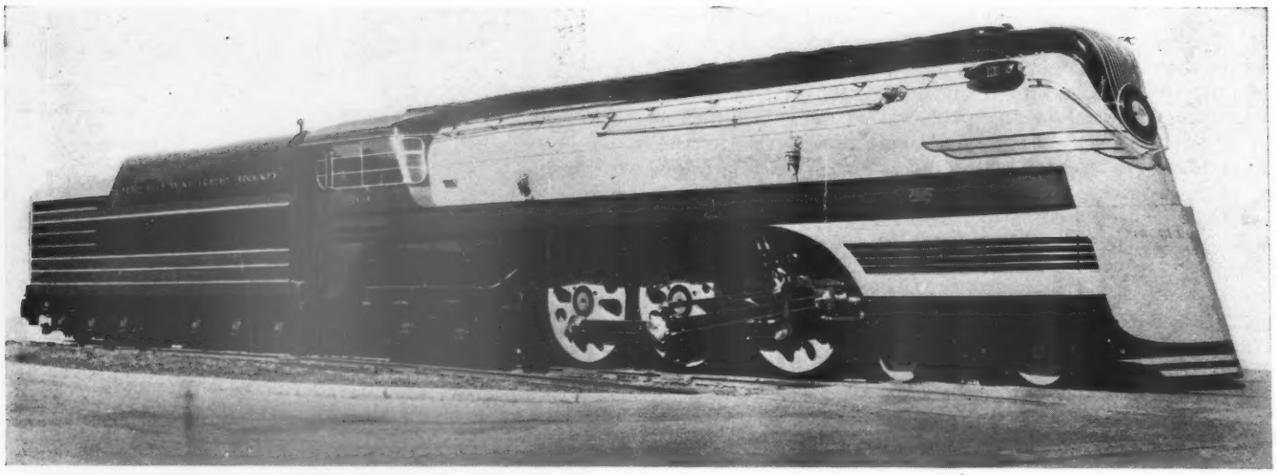


(2) Problems involved in high speed and modern operating practices.

Other features of the program will be a discussion of the association's activities, including changes in the constitution and by-laws to cover its new set-up, together with plans to establish it on a more substantial basis for future functioning.

In order to encourage closer contacts with the Mechanical Division, A. A. R., and to insure the maximum co-operation from the higher mechanical officers, it was decided to ask several of them to serve as an advisory committee, the members of this committee to review the proposed program and to assist in developing the organization along lines which will make its efforts most helpful and effective.

The officers of the association as elected last year and who will hold office during the present year are: President, F. B. Downey, assistant shop superintendent, Chesapeake & Ohio, Huntington, W. Va.; first vice-president, J. W. Oxley, general car foreman, Chicago & North Western, Maywood, Ill.; second vice-president, C. C. Kirkhuff, general foreman, Atchison, Topeka & Santa Fe, Chicago; third vice-president, J. C. Miller, general foreman, New York, Chicago & St. Louis, Conneaut, Ohio; fourth vice-president, J. E. Goodwin, general foreman, Missouri Pacific, North Little Rock, Ark.; secretary-treasurer, F. T. James, general foreman, Delaware, Lackawanna & Western, Kingsland, N. J.; chairman of the executive committee, J. B. Dunlop, Canadian National Railways, Leaside, Ont.



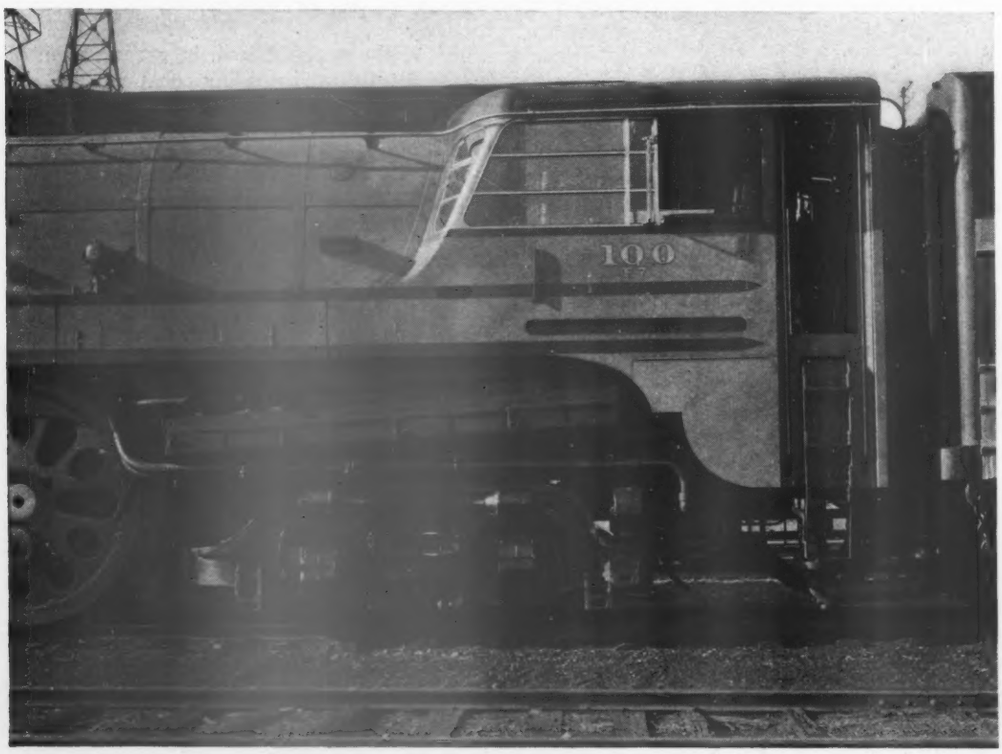
Distinctive Design Features 4-6-4 Type

Milwaukee Locomotives

Passenger motive power designed for heavy service develops tractive force of 50,300 lb. and weighs 415,000 lb. — Boilers have welded fireboxes

In August the American Locomotive Company delivered, from its Schenectady, N. Y., plant, six 4-6-4 type heavy passenger locomotives for service on the Chicago, Milwaukee, St. Paul & Pacific. While the new locomotives follow the general appearance of the original Hiawatha they are not solely for service on that train, but will be used on the Olympian and Pioneer Limited trains between Chicago and Minneapolis, a distance of 418 miles, and west of Minneapolis on the Olympian, to Harlowton, Montana, a distance of 914 miles. In the development of this "speedlined" design, Otto Kuhler, consulting engineer of design, collaborated with the railroad company and the builders.

These locomotives develop a tractive force of 50,300 lb. with a boiler pressure of 300 lb. and 84-in. driving wheels. The tenders carry 20,000 gallons of water and 25 tons of fuel.



The vestibule cab is of distinctive design and has a window arrangement which provides unusual visibility

Machinery Details

The foundation of these locomotives is a General Steel Castings Corporation's engine bed in which the cylinders, back cylinder heads, center plates, air reservoirs, link support, guide-yoke brackets, expansion-shoe pads, air-pump brackets and driver-brake fulcrums are cast as an integral part of the bed. The boiler is supported at the front and back of the firebox on expansion shoes, at the cylinders and by a waist sheet between the first and second pair of drivers.

The engine trucks are the General Steel Castings four-wheel type with 36-in. Davis cast-steel wheels, A. S. F. clasp brakes and Timken roller bearings. The driving wheels have Boxpok centers, 84-in. tires and Timken roller bearings. The journal diameter is 13½ in. at the main wheel and 12½ in. at the front and back. The Alco lateral-motion device is installed on the front pair of drivers.

The trailing truck is the Delta four-wheel type with centering device, furnished by the General Steel Castings Corporation with 38-in. Davis wheels at the front and 44-in. steel-tired wheels at the rear of the truck. The trailer wheels are equipped with A. S. F. roller-bearing units and clasp brakes.

The cylinders are 23½ in. bore by 30 in. stroke. Walschaert valve gear controlled by an Alco type H reverse gear actuates the 12-in. piston valves. The cylinder and valve chamber bushings are of Hunt-Spiller gun iron. The Z-type pistons are of rolled steel and both pistons and valves are fitted with Hunt-Spiller Duplex packing rings. Those on the pistons are the locked-lip type which require no bull ring and the valve rings are sectional bronze and iron.

The piston rod is of medium carbon steel, normalized and tempered, and is 5 in. in diameter. The crosshead and guides are of the multiple-bearing type. The main and side rods are of low-carbon nickel steel normalized, quenched and tempered. Floating bronze bushings are used at all pins with Hunt-Spiller fixed bushings in the rods. The crank pins are medium carbon steel and the main pin is hollow-bored.

The revolving weights at all wheels are cross-counterbalanced. The total weight of the reciprocating parts on each side is 1,681 lb.; the overbalance is 196 lb. on each wheel. The dynamic augment at 84 m. p. h. is 9,400 lb. in each wheel.

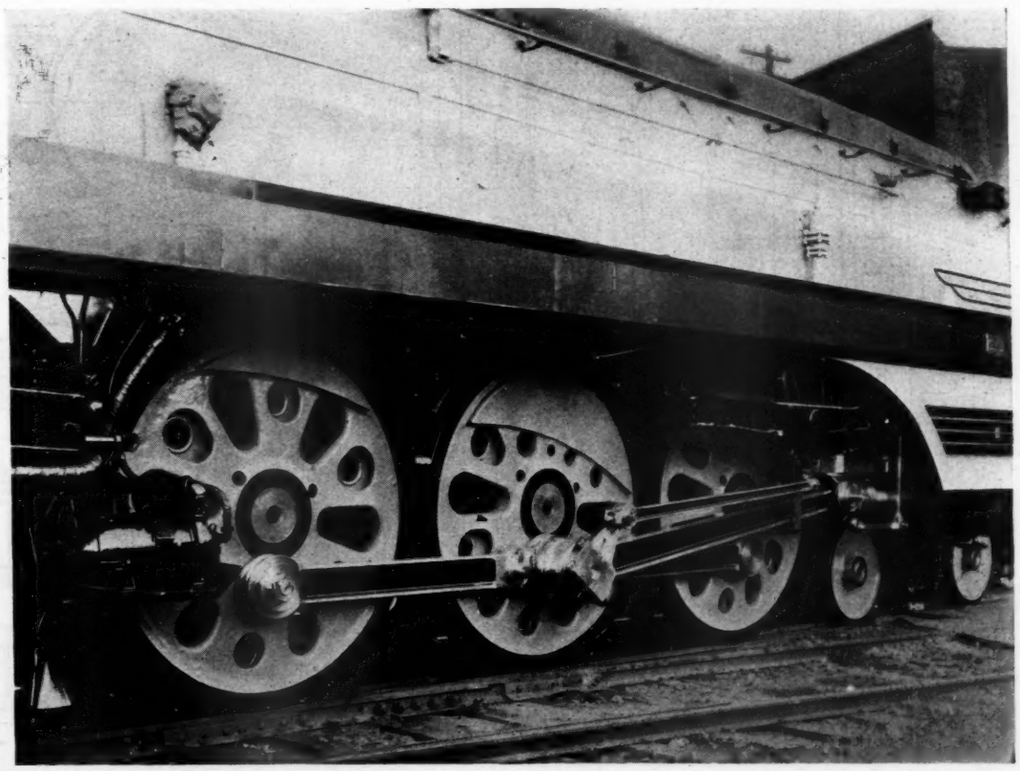
The Boilers

The boilers on these locomotives are built in three courses, the middle or dome course being conical in form. The inside diameter of the first course is 82½ in. and the outside diameter of the third course is 94 in. The thickness of the plate in the first course is ⅞ in. and $^{31}/_{32}$-in. plates are used in the second and third courses. The three barrel courses, welt strips and dome liner are silico-manganese steel having a maximum tensile strength of 82,000 lb. The front tube sheet is ¾ in. thick and the back tube sheet is ⅝ in. thick. The firebox is $96^{3}/_{16}$ in. wide by $144^{15}/_{32}$ in. long. The height from the bottom of the mud ring to the top of the crown sheet is 73½ in. at the rear and $88^{13}/_{16}$ in. at the front. The water space is 5 in. at the sides and back and 6 in. at the front of the firebox. The length of the combustion chamber is 44½ in. The roof and sides of the firebox are of silico-manganese steel similar to that used in the barrel course.

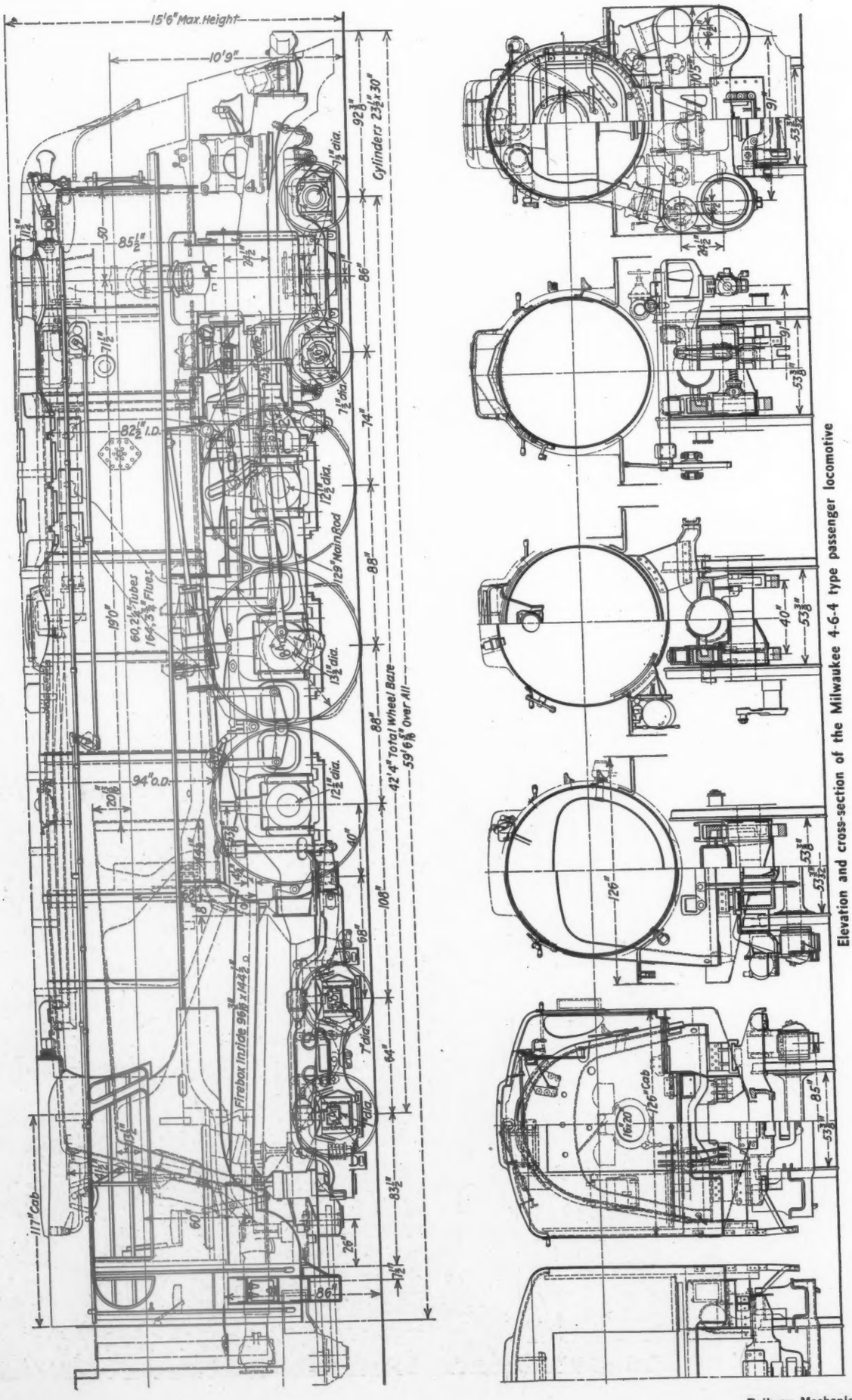
The roof sheet is $^{13}/_{16}$ in. thick while the outside side sheets are $^{9}/_{16}$ in. thick. The inside firebox sides and crown consist of three $^{13}/_{32}$ in. sheets welded together. Two Thermic syphons are located in the firebox, and a third one on the center line of the boiler is in the combustion chamber. In addition to the two syphons in the firebox, there are two 3½-in. arch tubes which, together with the syphons, support the American brick arch.

The boilers are fitted with sixty 2¼-in. tubes and one-hundred-sixty-four 3¾-in. flues. The length over the tube sheets is 19 ft.

The firebox is arranged for bituminous coal using Firebar grates. The grate area is 96.5 sq. ft. Coal is



The design of the streamline shrouding is such that the running gear is completely exposed



Elevation and cross-section of the Milwaukee 4-6-4 type passenger locomotive

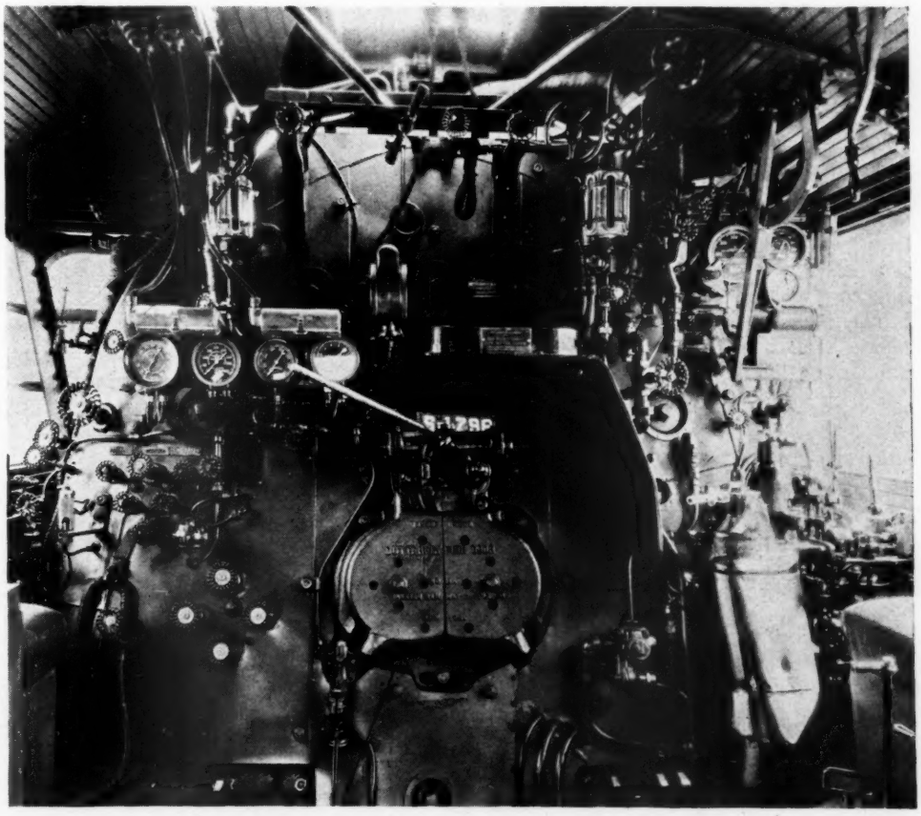
fed by means of a Standard modified type B stoker. The ash pans are of welded steel plate with cast-steel hoppers.

The fireboxes of these locomotives are completely welded. The firedoor flange, inside door sheet, inside throat sheet and back tube sheet, as well as the longitudinal seams which join the crown and inside firebox side sheets are welded butt joints.

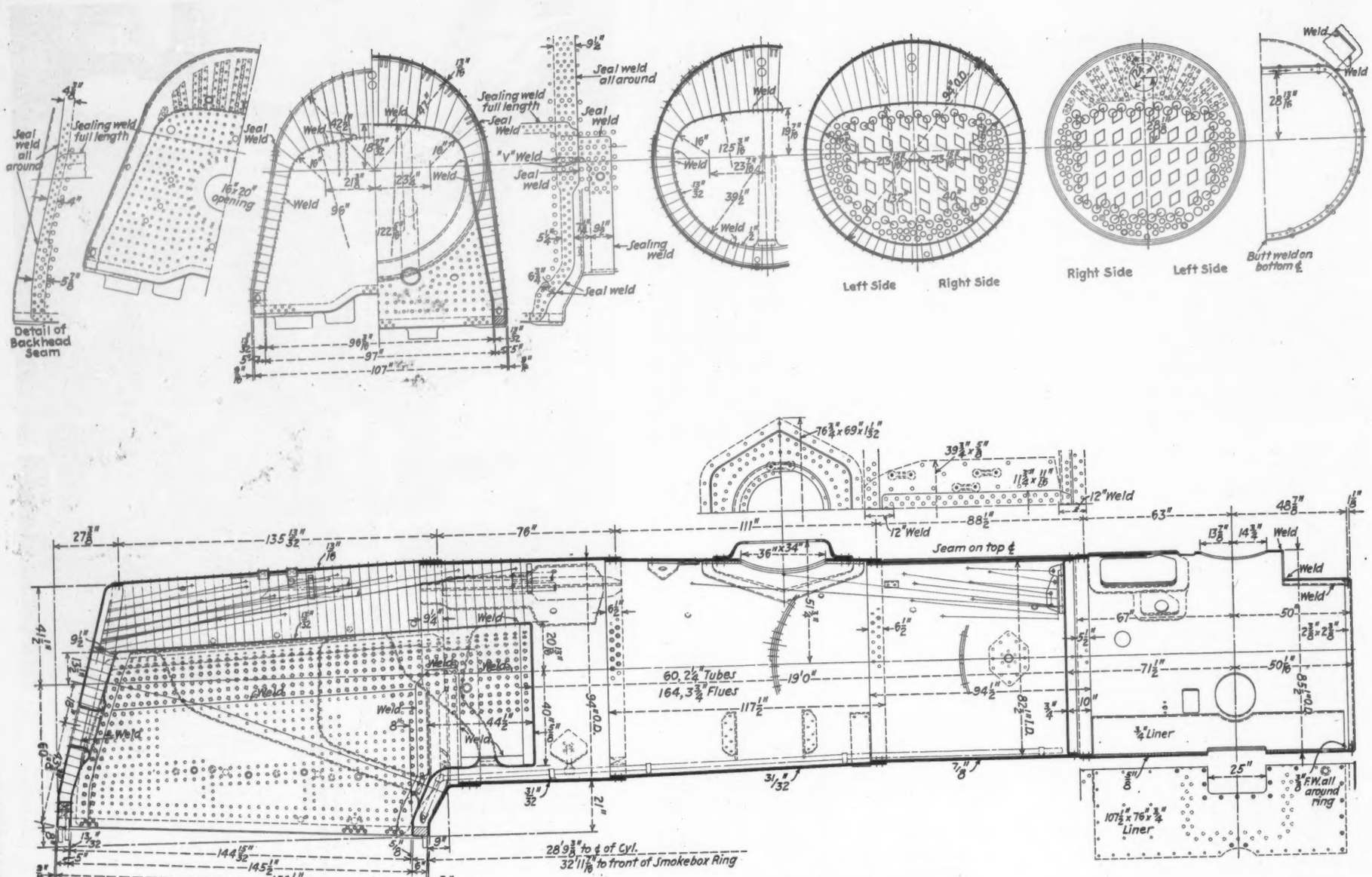
Alco flexible stays have been used extensively. Flexible expansion stays of the WZ type are used in the first six rows across the front of the combustion chamber. Two rows of flexible radials of the WY type are used at the edge of the crown sheet. WZ type sleeves

General Dimensions, Weights and Proportions of the C. M. St. P. & P. 4-6-4 Type Locomotives

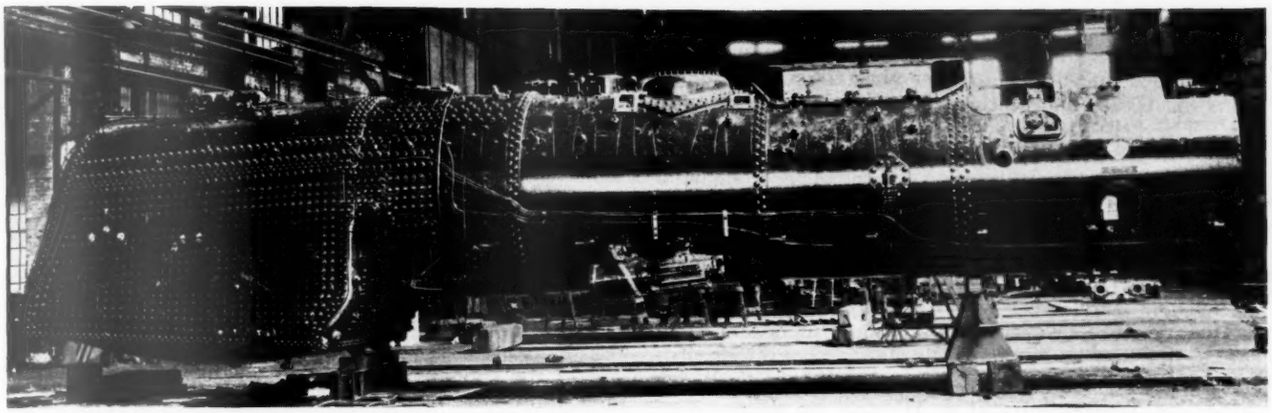
Railroad	C. M. St. P. & P.
Builder	American Locomotive Co.
Type of locomotive	4-6-4
Road class	F-7
Road numbers	100-105
Date built	1938
Service	Passenger
Dimensions:	
Height to top of stack, ft.-in.	15- 3
Height to center of boiler, ft.-in.	15- 6
Width overall, ft.-in.	10- 6½
Cylinder centers, in.	91
Weights in working order, lb.:	
On drivers	216,000
On front truck	82,500
On trailing truck:	
Front	53,000
Back	63,500
Total engine	415,000
Tender	375,000
Wheel bases, ft.-in.:	
Driving	14- 8
Rigid	14- 8
Engine, total	42- 4
Engine and tender, total	89- 10
Wheels, diameter, outside tires, in.:	
Driving	84
Front truck	36
Trailing truck:	
Front	38
Back	44
Engine:	
Cylinders, number, diameter and stroke, in.	2-23½×30
Valve gear, type	Walschaert
Valves, piston type, size, in.	12
Maximum travel, in.	7½
Steam lap, in.	1 1/16
Exhaust clearance, in.	¼
Lead, in.	5/16
Cut-off in full gear, per cent	84
Boiler:	
Type	Straight top
Steam pressure, lb. per sq. in.	300
Diameter, first ring, inside, in.	82½
Diameter, largest, outside, in.	94
Firebox length, in.	144½
Firebox width, in.	96 5/16
Height mud ring to crown sheet, back, in.	73½
Height mud ring to crown sheet, front, in.	88 13/16
Combustion chamber length, in.	44½
Arch tubes, number and diameter, in.	2- 3½
Thermic syphons, number	3
Tubes, number and diameter, in.	60- 2¼
Flues, number and diameter, in.	164- 3¾
Length over tube sheets, ft.-in.	19- 0
Fuel	Bituminous
Grate area, sq. ft.	96.5
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	348
Arch tubes	19
Thermic syphons	91
Firebox, total	458
Tubes and flues	3,708
Evaporative, total	4,166
Superheating	1,695
Combined evap. and superheat	5,861
Tender:	
Type	Rectangular
Water capacity, gal.	20,000
Fuel capacity, tons	25
Trucks	6-wheel
Rated tractive force, engine, lb.	50,300
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	52.1
Weight on drivers ÷ tractive force	4.29
Weight of engine ÷ evaporation	99.6
Weight of engine ÷ comb. heating surface	70.8
Firebox heat. surface, per cent comb. heating surface	78.1
Tube-flue heat. surface, per cent comb. heating surface	63.3
Superheat surface, per cent comb. heating surface	28.9
Firebox heating surface ÷ grate area	4.75
Tube-flue heating surface ÷ grate area	38.4
Superheat. surface ÷ grate area	17.6
Comb. heat. surface ÷ grate area	60.8
Evaporation ÷ grate area	43.2
Tractive force ÷ grate area	521.0
Tractive force ÷ evaporation	12.1
Tractive force ÷ comb. heating surface	8.58
Tractive force × diameter drivers ÷ comb. heating surface	721.0



The cab window arrangement of these locomotives provides a well lighted interior



Boiler cross-sections and elevation of the Milwaukee 4-6-4 locomotives



One of the boilers ready for the erecting floor

and caps are used for the flexible water space stays in the combustion chamber as well as a complete installation in the throat sheet. WZ type flexible water space stays are used in the breaking zones of the side and back head. There are four 2-in. combustion flues on each side of the firebox.

The boilers are equipped with the Barco type F3a low-water alarm, Wilson sludge remover together with Wilson blow-off cocks and muffler. Franklin butterfly type firedoors, Superior flue blowers and T-Z smoke consumers constitute part of the equipment.

Saturated steam passes through a Tangential steam dryer in the dome, through a 10-in. diameter steel dry pipe to an American multiple throttle built into the header of the Type E superheater.

Cab and Auxiliary Equipment

The brake equipment on these locomotives consists of the Westinghouse No. 8ET schedule with two 8½-in. cross-compound compressors. The main reservoirs are cast as part of the engine bed and have a capacity of 55,000 cu. in. The braking ratio on the engine truck is 45 per cent, on the drivers 60 per cent, and on the trailer 43 per cent. The engine truck brakes are operated by two 10-in. by 8-in. cylinders, the driver brakes by two 16-in. by 10-in. cylinders and the trailer brakes by four 8-in. by 8-in. cylinders. The train-control equipment is the Union Switch & Signal two-element type with three-indication cab signals. The locomotives are fitted with Valve Pilot speed recorders.

The air compressors are mounted under the streamline shrouding just back of the pilot. The air-compressor exhausts, together with the exhaust from the feedwater-heater pump, enter a header on the outside of the smokebox which is connected to a tunnel on the inside of the smokebox. The upper end of this tunnel discharges into a cavity cast integral at the rear of the stack. The generator is on a cast-steel bracket back of No. 3 driver on the right side.

The generator and headlight equipment were furnished by the Pyle-National Company.

The main cab turret is just forward of the cab under the cowling. It is connected inside the boiler with two 3-in. pipes leading from the dome. Saturated steam from this turret is supplied to the flue blowers, cab heaters, stokers, injectors, water conditioner and steam heat. Superheated steam is supplied to the whistle, air pumps and generator from a separate turret.

The cab is of the vestibule type, of welded copper-bearing steel, wood lined and insulated with Hairinsul. A recess in the exterior of the cab sides provides a toe hold for passing from the cab to the running board. Steam radiators have been installed on both sides of the cab and in the gangway. There are two seats, with Spongex cushions, on either side and drop seats are mounted on the rear vestibule wall on both right and left sides.

The metal cab-window sash were supplied by the O. M. Edwards Company and have shatter-proof glass in all sash.

On the front of these locomotives is a Buckeye type E folding coupler with a 6-in. by 8-in. shank. The Franklin Type E2 radial buffer is installed with the Unit Safety drawbar. Barco flexible connections are used between the engine and tender.

Lubrication

Mechanical lubricators supply the force-feed oil lubrication. A Nathan DV5 26-pint lubricator on the right side distributes oil to the valves and cylinders as well as the stoker and air pumps. A five-feed lubricator of 24 pints' capacity on the left side distributes oil to the driving boxes and guides. Three of the locomotives in this order have Detroit lubricators on the left side and the other three have Chicago lubricators. Both lubricators are driven from connections at the top of the combination levers.

Pressure grease lubrication is used extensively. Altogether 236 Alemite fittings are used on the engine and tender. The engine truck has 27 fittings, the crossheads, guides, motion work and reverse gear 42 fittings, the trailer truck 21 fittings, and the tender truck 58 fittings. Additional fittings on lubricator drives, valve-stem and crosshead guides, throttle rigging, motion, side rods and crank pins, spring and brake rigging, and wheels and boxes total 74 fittings. Rex fittings are used at 12 points on the driving boxes.

Streamlining

The streamlining on this locomotive follows the general theme of the first Hiawatha locomotive as far as the front end is concerned, which is at an angle of 16 deg. to the vertical. Every effort was made to adapt the form of the shrouding to established structural lines.

The front of the streamline shrouding opens at the center line on concealed hinges, giving access to the smokebox front, whistle and air-horn mountings. The air pumps are on either side of the front end behind the pilot skirting and are accessible through hinged side panels in front of each cylinder. A removable panel gives access to the hinged-type coupler. There is a grille above the headlight in front of the whistle and horn. This grille is made up of flat rolled-steel bars

with the narrow edge to the front trimmed with Snap-on stainless steel molding. These metal-trimmed bars are arranged in such a manner that the headlight remains the focal point of the front "face" of the locomotive. The original Hiawatha wing ornament has been retained in a somewhat modified form. This ornament is of stainless steel with a satin finish. The front hand rails are fitted to follow the lines of the headlight and wings and thereby become a part of the ornamentation. The road name is attached to the pilot skirting in stainless steel letters.

The pilot skirt is continued around the cylinders for aerodynamic and protective reasons and in order to accentuate the appearance of height and power rather than of width. The ornamental panel of the side cylinder skirting is continued forward so as to be visible from the front. In order further to relieve the appearance of bulkiness, the pilot skirting merges to a point at the bottom.

While the predominating color of the front end is gray, the horizontal striping of maroon and Milwaukee orange yellow as applied to the skirting below the running board has been continued around to the front in the same manner as the black-and-metal-striped panel on the cylinder skirting. On the bottom of the pilot skirt a maroon design breaks up the appearance of width by following the front edge of the striped cylinder panel. In addition to the ornamental value, the colorful appearance of the front of the locomotive has a decided safety value inasmuch as it is possible to observe it at great distances.

The cowling of the stack, sandbox and dome ends in a fishtail shape on the cab. The unbroken contour of this cowling contributes to smooth smoke flow and obviates the necessity of smoke deflectors. This cowling has been painted black. To retain a distinctive characteristic of the steam locomotive, a streamline cap has been shrouded around the stack and a smoke fin blended into the silhouette. The marker lamps are of special design. The stainless steel side hand rail runs back from the marker lamps and follows the contour of the boiler jacket and cab. Streamline brackets secure the hand rail in place. Between the top cowling and the running board the shrouding follows the boiler contour lines and is painted gray. The throttle arm, injector checks and flue blowers have not been covered.

The cab is a decided departure from conventional design. Every effort was made to increase visibility. This has been achieved by a narrow steel corner post permitting an increase in the clear width of the front cab windows. The length of the cab is further emphasized by the use of aluminum sash with narrow horizontal mullions. By this means the glass area is greatly increased, providing a well-lighted cab interior. The vestibule cab door and window which furnishes unusual visibility follow streamline design of the sash.

Recognizing the public's interest in seeing the mechanism of the locomotive in action, the running gear has been exposed to full view by terminating the running board skirting above the tops of the drivers. The lower end of the running board drops down in a curve under the cab to the lower line of the tender and cars. Following the colors of the cars, the running board skirt has been painted in Milwaukee yellow with broad maroon skirts at the upper and lower edge. The wheels are painted gray with maroon rings around the ends of the axles on the hub, and the side, main and eccentric rods are highly polished with maroon in the channels. A chromium-plated builder's name plate is attached to the skirting at the cylinders and the name plate of the speedline designer has been applied below the builder's plate in the black cylinder panel.

The tender treatment follows the color arrangement of maroon and yellow characteristic of the new 1938 passenger equipment.

The Tender

The tender tank is of all-welded construction and is built up on a Commonwealth water-bottom cast-steel underframe. The water capacity is 20,000 gallons and the coal space carries 25 tons. The hot well for the Wilson feed-water heater is on the left side behind the coal space.

The tender trucks are of the equalized six-wheel Commonwealth type with 38-in. Davis wheels and A. S. F. roller-bearing units. A. S. F. clasp brakes are used with 14-in. by 10 in. brake cylinders mounted inside on each truck. The braking ratio is 80 per cent.

The steam-heat connectors at the rear end of the tender are the Vapor flexible metallic type. The draft gear is the Miner velvet action passenger gear with Buckeye Type E coupler and yoke.

* * *

A good job of smoke prevention—Erie suburban locomotives stored at Jersey City, N. J., with fires banked

Master Boiler Makers' Association Meeting

(*Continued from page 415*)

fire as thin as possible over the entire grate surface. (3) Keep the firebox and front end in good condition, free from leaks, and clean flues when necessary. (4) Firebox sheets, tubes and flues should be kept free from scale. (5) The locomotive should be properly drafted.

Report by A. W. Novak

It has been said that leaky flues and fireboxes are chiefly responsible for the honeycombing and slagging. This is not true in all cases for I have seen cases of flue sheets honeycombing to the extent that 60 per cent of the flues were completely covered over with honeycomb from 1½ in. to 2 in. in thickness; nevertheless, no leaks existed in firebox or flues. After honeycomb was removed, inspection of flues showed them to be in clean condition, the front end was drafted according to standard practice and inspection during water test showed no leaks, nor were any air leaks found after the locomotive engine was fired up. Again, I have seen cases of flues and fireboxes leaking, as well as leaks in front end, where no honeycomb adhered to flues and tubes. Therefore, as above stated, firebox leakage is not in all cases responsible for the troublesome deposits on flue sheet commonly known as honeycomb. However, firebox leakage, improper drafting and other characteristics will aid materially in the honeycombing when certain grades of coal, which could be termed objectionable, are used.

Report by B. C. King

Slag contains iron in some form combined with a percentage of silicon and ash. The formation of slag is developed by any condition that retards combustion, causing temperature changes which will not produce enough heat to convert the mineral particles of fuel into nonfusible substances.

Honeycomb differs from slag inasmuch as the iron content is lower, with increase in the percentage of silicon and ash, and is caused chiefly by any condition that shortens the time element of combustion.

The fusing point of ash and clinkers may be divided into three stages: The initial point, the softening point, and the fluid point. For different fuels any decrease in temperature after fluidity has been attained will naturally tend to affect the density and hardness of the clinker.

The rate of burning has a definite bearing on the percentage of clinker formation in ash. The highest percentage of clinker formation has been found to occur at a rate of burning of 20 to 30 lb. of coal per sq. ft. per hr. The quantity of clinker decreases as the burning rate increases, although density and fusion are greater at higher rates. The rate of decrease of quantity of clinker becomes less for low ash-fusion temperature. Escape of gases through prolonged high temperature permits the formation of less brittle clinker.

The presence of iron in pyritic form or lime, in sufficient quantity, causes honeycombing or slagging. Coals with high iron content and low fusion point present the greatest problem.

Pyritic iron undergoes a chemical change at 800 to 900 deg. F. becoming ferrous sulphite. It adheres to small pieces of unburned fuel and is carried along by the draft and thrown against the surface of side sheets, staybolts and flue beads in semiplastic condition. Then heat drives off the volatile and combustible matter, leaving ash as honeycomb.

High percentage of iron or lime in the coal causes melting points as low as 1,800 to 2,000 deg. F., while alumina and silica raise the melting point from 2,600 to 3,000 deg. F. High silica and alumina ash are not readily fusible and usually ash low in iron and lime has high silica and alumina. Coal high in sulphur will generally clinker easily, and from this will form honeycomb and slag.

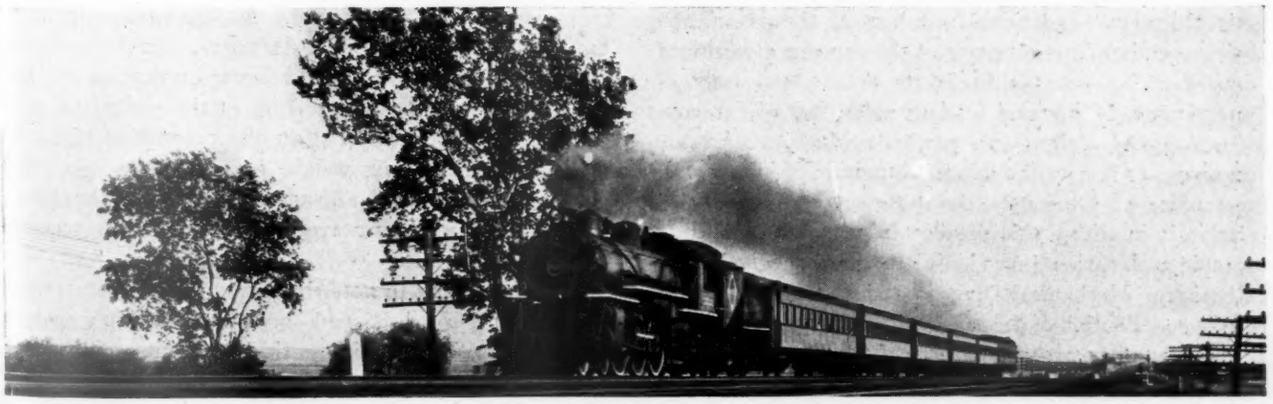
Causes of slag and honeycombing are leaky superheater units, leaks in firebox or flues, mud and scale in the boiler on firebox sheets or flues, holes in brick arch, defective grates with uneven openings for air admittance, improperly drafted front ends, air leaks in the front end, and stack out of line.

The prevention must consist first of keeping up maintenance so that there will be no leak of any kind either in the front end or firebox, and second, keeping up repairs to valve and cylinder rings to prevent an excessive demand for steam beyond the economical capacity of production.

Another preventive which has come under my observation is to lower the arch at the back end, making the arch as flat as possible, and to run the bricks as close to the door sheet as possible. This arrangement will entirely consume the iron in pyritic form and heat up the lime so that the honeycombing and slagging is lessened and will not adhere to firebox surfaces.

In conclusion I recommend that the design of power should contain more grate area and more firebox area to consume the fuel which becomes plastic. This can be accomplished by longer combustion chambers, and also by a flatter and longer brick-arch surface, leaving only sufficient opening between arch and door sheet to withstand the heat at the door; such an opening should be as near as possible to 120 per cent of the flue opening.

* * *



EDITORIALS

Car Officers Association Makes Real Progress

At the annual meeting of the Car Department Officers Association, held September 27-28 at Chicago, reported elsewhere in this issue, the total registration of members and guests was 191, this attendance being secured in an off-year with no exhibition of equipment and supplies to act as a drawing card and in spite of heavy pressure to curtail traveling expenses. The program included a total of ten committee reports which presented, in the aggregate, a large amount of information designed to increase the efficiency of car department operation. In general, the outstanding feature of the entire meeting, aside from the practical character of most of the reports, was the very pointed and pertinent discussions, which in some instances took more time than the reading of the original reports. These discussions were eloquent testimony to the value of the reports and the importance of the subjects under consideration.

The best answer to any question which might be raised regarding the potential importance of the Car Department Officers Association and the very real progress it is making may be obtained by a study of its proceedings. As pointed out in the report of its Publicity Committee, the 1937 meeting was considered sufficiently worth while that 1,150 copies of the proceedings were distributed, in addition to which abstracts of certain committee reports were widely publicized in the technical press. In the *Railway Mechanical Engineer* alone, for example, during the past year, almost 30 pages of editorials, news items and convention reports have been published, carrying valuable information, interesting news and doubtless some inspiration to car men throughout the country.

The Car Department Officers Association, through its regularly-elected officers, has repeatedly indicated its keen desire to supplement and in no way overlap the work of the Association of American Railroads, Mechanical Division, and experience indicates that with proper direction it should be entirely feasible to realize this objective. Individual members of the association bring together from all parts of the country a wealth of experience in the multitudinous details, not only of interchange, billing and loading rules, but of car construction and maintenance methods which are far too numerous to receive the detailed attention of higher railway officers. Obviously, the more successful the association is in sifting this detailed information, analyzing specific problems and developing practical suggestions as a basis for Mechanical Division action, the greater will be the contribution of the association to railway progress.

Still another very important function of the Car Department Officers Association is in developing men and training them to think clearly and speak effectively. The Association's meetings should be a forum where all may be heard in the presentation of ideas some of which, classed as impossible today, may prove factual tomorrow. Recognizing the desirability of avoiding "steam roller" tactics in suppressing debate, and, on the other hand, stimulating full and free discussion of all pertinent subjects, however controversial, it must be recognized that in the long run the reputation and future growth of the association will depend upon how effectively it keeps its feet on the ground and develops recommendations on all car matters which are basically sound and practicable.

Weight and Power Ratios of High-Speed Trains

On another page in this issue, in the report on Steam Turbines and Diesel Locomotives, which was presented at the recent meeting of the Fuel and Traveling Engineers Association, is a table showing comparisons of several Diesel-electric and steam locomotives and modern high-speed passenger trains in which the ratio of locomotive weight to the total weight of the train and the total weight of train per horsepower (engine or indicated) is given. This table is of interest because it shows the effect of several factors in determining the final proportion of total weight which must be reserved for the locomotive and the effect of this weight on the total horsepower required for various operating conditions. These factors are the weight per horsepower of the locomotive ready for service, the number of cars and average weight per car, and the pounds of total train per horsepower of the locomotive. The latter figure is in some measure an indication of the top speed which can be attained from the locomotive hauling its train. The importance of high weight efficiency in a locomotive design, whether Diesel or steam, is clearly indicated. As the total weight of the train per horsepower decreases, the locomotive weight becomes a rapidly increasing proportion of the total train weight. A reduction in the weight of the cars does not materially affect the proportion of locomotive weight to train weight for a given weight efficiency. It therefore affects proportionally the total amount of horsepower required for a given weight —horsepower ratio.

It is interesting to note that few of the steam trains tabulated are proportioned for extremely high speed, several of them showing ratios of train weight per horsepower of over 600 lb. and only one having a ratio

of less than 500 lb., while only a few of the Diesel trains have weight-power ratios greater than 500 lb.

Modern Equipment Needed To Reduce Expenses

The experience of recent years has indicated that, with increasing competition of other forms of transportation, the prospects of adding greatly to the gross revenues of the railroads are not particularly bright, surrounded with some uncertainty even with an improvement in general business conditions. For this reason, it is of great importance that every opportunity be grasped to effect permanent and substantial reductions in the cost of operation.

As far as the mechanical departments are concerned, they are directly responsible for the largest single item of operating expense—steam locomotive repairs—and, indirectly have considerable control over the fuel expense. These two items of operating expense, plus the expenditures for freight and passenger car repairs, amounted in 1937 to over 550 million dollars.

There are, therefore, two avenues open over which the mechanical officers have considerable control, the cost of locomotive operation and the cost of car and locomotive maintenance. With 67 per cent of the steam locomotives in this country over 20 years of age, it is well recognized that, as rapidly as funds can be found to finance their purchase, the introduction of modern motive power will contribute immeasurably to substantial reductions in the expense for fuel and maintenance.

In these days of small equipment replacement programs, the shop and engine terminal supervisor is working against odds in his battle to reduce maintenance costs for, if for no other reason, the increasing age of motive power brings about increases in the unit costs of repairs while, at the same time, a similar condition with respect to machine tools and shop equipment is making it more and more difficult to turn out repair work as economically and efficiently as it could and should be done with modern equipment. It is a case where the cost of repairs is automatically increasing because of a condition that can only be remedied by the modernization of equipment and repair facilities.

Whatever may be the ultimate outcome of the wage controversy, it does not alter the fact that the railways must save money.

It would seem, therefore, the railroad managements have arrived at a point where they must make a decision as to the future course to be followed in order to assure that their properties may remain solvent. Fortunately, with respect to both locomotive equipment and the facilities with which they are maintained, the records of performance of such equipment as has been installed in the last five or six years, proves conclusively that substantial reductions in operating and maintenance costs can be made.

Symptoms or Coincidence?

Two locomotive boiler explosions which occurred during the past summer have attracted more than ordinary attention. These were the failures of the boiler of an articulated freight locomotive on the Northern Pacific which completely wrecked the engine and part of the train, and the dropping of the crown sheet of the boiler on a Pennsylvania passenger locomotive without separating the boiler from the frames and, indeed, without derailing or stopping the locomotive and train until they had proceeded for several miles. Both failures were caused by low water and a contributing cause in each case was the partial ineffectiveness of the boiler feeding apparatus.

The firebox of the Northern Pacific locomotive was of unusual size; the crown sheet measured 26 ft. 9 in. in length. The evidence indicates that the water level had fallen only about 1 in. below its highest point at the time the crown sheet dropped. In the case of the Pennsylvania locomotive the water level apparently had dropped 5½ in. below the highest point on the crown sheet.

The number of such accidents and the resulting casualties have shown a gratifying reduction since the boiler inspection law first became effective in 1911. For the fiscal year ended June 30, 1912, there were 856 accidents caused by the failure of some part or appurtenance of the steam locomotive boiler. In these accidents 91 persons were killed and 1,005 injured. During the fiscal year ended June 30, 1937, there were 63 accidents, in which 19 persons were killed and 73 injured. Not all of these are low-water accidents, but most of the casualties, particularly the deaths, are associated with that type of accident.

It is probably too much to expect that the time will ever come when there will be a complete absence of crown-sheet failures. Considered in the light of this probability, the significance of these two accidents does not lie in the fact that the crown sheets failed, that the failures resulted from low water or, indeed, that each was the cause of loss of life. It lies in the fact that in each case during a considerable period immediately preceding the accidents the records show that repeated reports had been turned in by the enginemen on the improper functioning of the feedwater apparatus.

Following the Northern Pacific accident examination of the feedwater feeding equipment disclosed the fact that the packing ring of the drifting-control-valve piston was missing. The leakage of steam past the piston of this valve, the purpose of which is to cut down the speed of the hot-water pump when the locomotive is standing or drifting and automatically to cause it to operate according to the opening of the pump throttle when the locomotive is working steam, may result in the piston remaining stationary or not moving sufficiently to permit the full steam flow to the pump, thereby decreasing its capacity. During the 17 days prior to the accident eight separate reports indicating that the

water pump was unable to supply the boiler were made by seven different enginemen. In each case the record indicates that repairs or examinations of the water pump were made. In one case the engineman apparently suspected the nature of the defect and asked for examination of the drifting control valve and the float to the water pump. In his report of the investigation Chief Inspector Hall of the Bureau of Locomotive Inspection says that "the reduced capacity of the boiler feed pump caused by a defective drifting control valve was a contributing factor."

During a period of approximately one month prior to the failure of the crown sheet on the Pennsylvania locomotive six reports by three enginemen all indicate that one or both of the injectors failed to supply the boiler or fully to take up the water. Examination following the accident showed that the two injectors were so installed that with the steam-valve handles in the full open position the steam valves were actually something less than fully open, thus producing a condition in which the injectors were much more liable to break than would normally be the case. The temperature of the water in the tank indicated that one of the injectors, with the overflow valve closed, had broken and had blown steam back into the tank for some time.

The facts in both cases indicate complete futility on the part of the maintenance forces in their attempts to locate these repeatedly reported defects which ultimately were the cause of, or at least contributed to, destructive crown-sheet failures resulting in the death of seven persons and jeopardizing the lives of many others. Can these failures to make effective repairs be attributed to a certain callousness resulting from traditional differences of viewpoint between engine crews and enginehouse forces? We are reluctant to believe so. And yet it would seem that a repetition of reports in a matter so vitally affecting safety would cause an uneasy foreboding in the enginehouse which would not be relieved until the underlying cause of repeated work reports had been discovered and removed. Are not two widely separated cases of the failure or ineffectiveness of such an attitude a possible warning that budget trimming is beginning to exceed the limits of safety?

Welding Engineers Are Needed

It is generally recognized that welding of all kinds has made phenomenal strides in recent years in both the heavy goods industries and the transportation field. Electric and gas welding and cutting have revolutionized construction and maintenance methods in the railway equipment field. Welding, however, like Topsy, has more or less just grown and there can be no question that its progress has been hampered and delayed to a certain extent by the lack of an adequate number of engineers with the specialized training and experience essential in developing designs which employ the maximum economic use of modern welding methods. Moreover, the technique of welding is in such a state of flux and constant improvement that only the most alert and well-read students of the welding art can hope to keep abreast of the times.

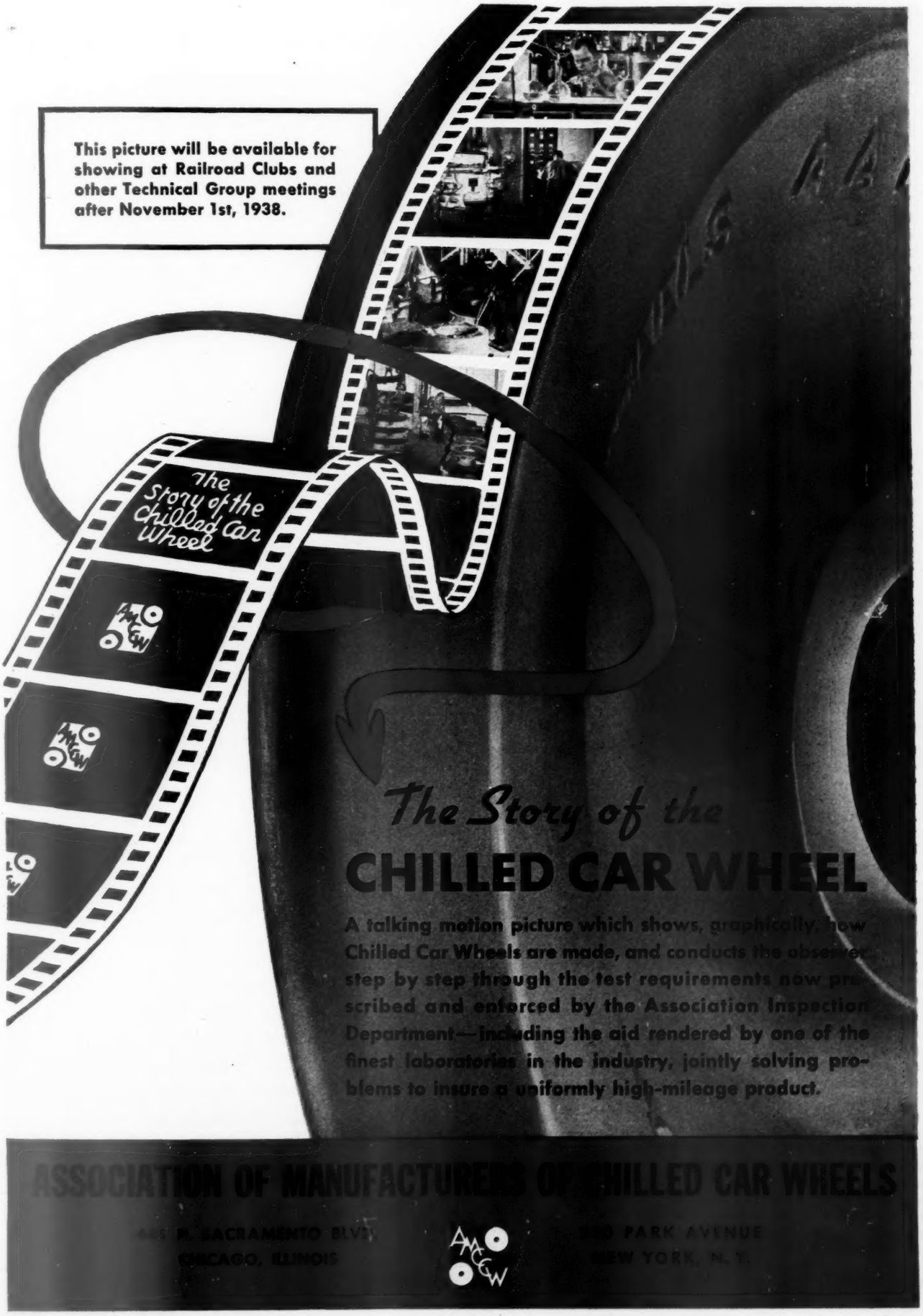
A fact, sometimes overlooked, is that civil, mechanical, metallurgical and other engineers each have a rather definite and well-recognized vertical field of activity, whereas the welding engineer operates in what might be termed a horizontal field, cutting directly across all of the others. For example, a mechanical engineer well able to design welded joints and distribute stresses properly among the members of a given structure frequently lack the knowledge of how the welding operation might affect the properties of the metal involved, which is a problem in the field of metallurgy. In this connection, it is interesting to note that, among others, Ohio State University has just announced a new course of study leading to a degree in welding engineering which will embrace all branches of modern welding and endeavor to give men a special training in this new technology to supplement the other engineering courses.

All training and development work along this line should be encouraged and it is equally important that those engineers of design, particularly in the railway field, who have long since passed their period of formal schooling, start delving into the literature and practical application of modern welding practice, thus familiarizing themselves with the technique of the art so that full advantage may be taken of its possibilities without stumbling over any of its limitations.

New Books

QUESTIONS AND ANSWERS ON BRAKE EQUIPMENT. *The Air Brake Association, 3416 Empire State building, New York. Book No. 9—No. 8-ET Locomotive Brake Equipment, 75 cents; Book No. 10, "AB" Freight Car Brake Equipment, 75 cents; Book No. 11, "AB-8" Automatic Empty and Load Freight Car Brake Equipment.*

Book No. 9 contains over 300 questions and answers covering new developments and operating characteristics of the improved ET equipment as designed for service on modern locomotives. Book No. 10 contains questions and answers on the new standard brake equipment developed for long trains in modern high-speed freight service. Book No. 11 is supplementary to Book No. 10. It contains questions and answers on the new equipment which automatically changes the braking force when a car is more than half loaded or less than half loaded, and covers only the devices that are used in addition to standard AB equipment. In Books 9 and 10 are descriptions of the parts making up the No. 8-ET and AB equipment, respectively, as well as diagrammatic views of their application in various positions. The AB valve diagrams are in color.


This picture will be available for showing at Railroad Clubs and other Technical Group meetings after November 1st, 1938.
The Story of the Chilled Car Wheel
The Story of the
CHILLED CAR WHEEL
A talking motion picture which shows, graphically, how Chilled Car Wheels are made, and conducts the observer step by step through the test requirements now prescribed and enforced by the Association Inspection Department—including the aid rendered by one of the finest laboratories in the industry, jointly solving problems to insure a uniformly high-mileage product.
ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS
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High Spots in

Railway Affairs . . .

The Supervisor and Safety

The National Safety Council celebrated its silver jubilee in Chicago last month. In addressing the Steam Railroad Section, John E. Long, superintendent of safety of the Delaware & Hudson and a past-president of the Council, stressed the vital importance of the supervisors as key men in insuring safe operation. "They should have the ability to detect unsafe practices and correct them before the accident happens," said Mr. Long. "Just because an operation has been performed many times without an accident," he continued, "does not imply that it is a safe method; many accidents are caused by following presumably safe practices which were actually unsafe, but the hazards of which had not been detected. An accident is really a mistake coming to light. . . ." Then he made this significant statement: "Statistics show us that there are about 30 accidents to equipment or material to every one that even slightly injures a human being and that there are about 300 minor injuries on the average to one lost-time injury."

Against Wage Reduction

The emergency fact finding board appointed by President Roosevelt, and consisting of Chief Justice Walter P. Stacy of the North Carolina Supreme Court; Dr. Harry A. Millis, retiring chairman of the Department of Economics of the University of Chicago; and Dean James M. Landis of the Harvard Law School, finally made its report on Saturday, October 29. It should have been presented before midnight on Thursday, the 27th, but the board asked for additional time. It concluded "that no horizontal reduction upon a national scale of the wages of railway labor should be pressed by the carriers at this time." This conclusion was based upon the fact that it found that the wages of railway labor are not high as compared with those in other comparable industries. It concluded also that a horizontal reduction of wages on a national scale would not meet the financial emergency of the industry, since the savings would not be distributed merely to the needy roads. The board believes that the financial distress of the carriers is a short term situation and cannot be regarded as grounds for a wage reduction, especially in view of present indications of an improvement in the business of the carriers. It believes also that a wage reduction in the railroad industry would run counter to the trend of wage rates in industry generally.

Not So Many Fires

Like the National Safety Council, the Railway Fire Protection Association celebrated its silver jubilee in October. Since it was founded 25 years ago, fire losses on the railroads have been cut more than one-half, insurance rates have been reduced and the total yearly insurance premiums paid by the railroads have dropped about 75 per cent. There were 4,932 fires on the railroads of the United States in 1937 as compared to 5,998 in 1936, the total loss in 1937 being $3,750,707. Sparks or hot coals from locomotives caused 323 fires, with a loss of $101,284. Of the properties, box cars suffered the most, with 1,033 fires and a loss of $604,547. Car shops had 23 fires with a loss of $343,818.

Where Do We Go From Here?

The fact finding board has found against a reduction in railway wages. It is doubtful if the public would stand for further increases in freight and passenger rates, even if the Interstate Commerce Commission approved of them. The Administration and Congress have admitted the seriousness of the railway situation, for several years, but have done nothing constructive to remedy it. Committees of Congress which have had to do with the railroad problem have spent their time investigating matters which in their minds were open to criticism, but have failed to face the railroad question in a large way; indeed, they have not even attempted to take any constructive action. Railroad labor leaders have advocated government ownership of the railroads and their actions generally have been such as to seriously lower the morale of the employees. Adequate railroad transportation is vital to the prosperity and best interests of the country. The railroad managements have done what they could to improve the services with the means at their disposal. Now it is up to President Roosevelt and Congress. The responsibility cannot be further evaded! What will they do?

Train Accident Records Improve

Accident Bulletin No. 106, recently issued by the Interstate Commerce Commission's Bureau of Statistics, shows that 5,350 persons were killed and 36,692 injured on the railroads during 1937; this compares with 5,398 killed and 34,706 injured in 1936. A special analysis of train accidents indicates that "the cause for the interruption in 1934-36 in the downward trend was the increase in accidents due to the condition of track or equipment, probably the result of decreased expenditures for maintenance in the years of low railway revenues." The tabulation of accidents from the standpoint of speed indicates that the greatest number of accidents occurred at speeds under 10 m.p.h., but in the aggregate, the greatest amount of property damage occurred at train speeds of 40 to 50 m.p.h., although the number of train-miles having no casualties may also have been greatest in this range. Reports made public by the Bureau of Railway Economics of the Association of American Railroads covering the first six months of 1938 show "the best general safety record ever established by the railroads for any similar period." Compared with the first six months of 1937 there was a reduction of 17.6 per cent in fatalities and 28.6 per cent in non-fatal accidents.

Digging Up Service Records Data

According to the terms of the Railroad Retirement Act, the railroads are required to bring up to date the service records of prospective pensioners. Arrangements have been made with the Works Progress Administration whereby furloughed railway employees eligible for W. P. A. work relief, will be assigned to railroad offices to do this work. The railroads will thus be relieved of this expense and when the work is completed the records will be in such shape that prompt action can be taken by the Retirement Board when applications are made for annuities. Railroad labor apparently will not object, provided the standard daily rate of wage is paid the workers and only furloughed railway employees are given the jobs. A. V. Vallandingham, assistant to comptroller, Delaware & Hudson, has been granted leave by that road in order to direct the project. The central office will be in Chicago and it is estimated that a W. P. A. appropriation of $18,000,000 will be required to create about 1,800,000 service files of individual records. The project as a whole will of necessity get under way slowly, because the W. P. A. requirements are such that a grant cannot be made upon a national basis, but must have the specific approval of each of the state directors as to the proposed set-up for their territories.

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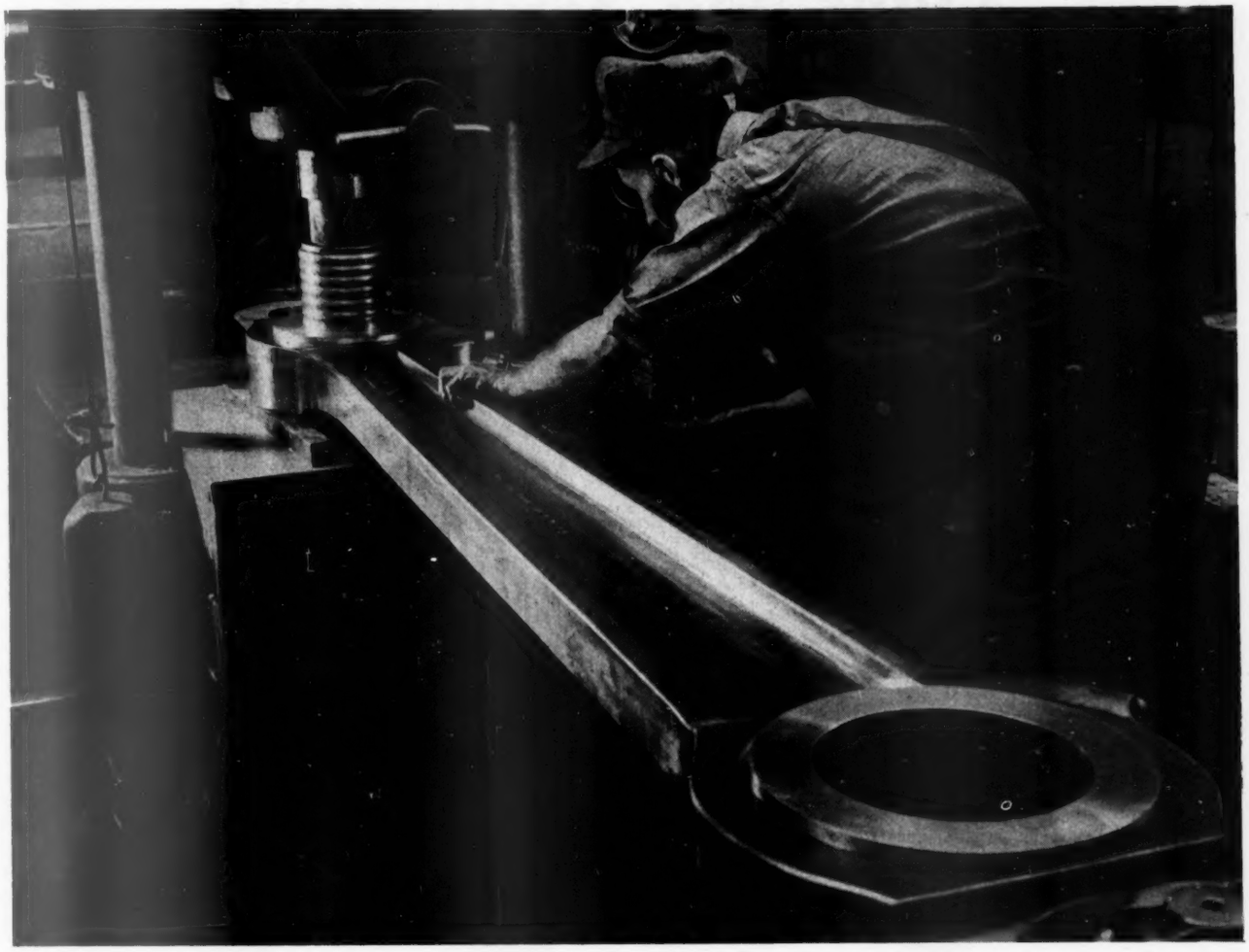
METHODS AND MACHINERY THAT GUARD LIMA QUALITY



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LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED INCORPORATED, LIMA, OHIO

Among the Clubs and Associations

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Loss and Damage Prevention and the Car Man is the subject to be discussed by Joe Marshall, special representative, A. A. R., at the November 14 meeting to be held at 8 p. m. at the LaSalle Hotel, Chicago.

NORTHWEST CAR MEN'S ASSOCIATION.—"Some Wheel Shop Observations" was the subject discussed at the November 7 meeting by H. F. Ripken, wheel shop foreman, Minneapolis, St. Paul & Sault Ste. Marie.

NEW ENGLAND RAILROAD CLUB.—C. C. Warne, purchasing agent, New York Central, discussed Railroad Purchasing at the November 15 meeting held at the Hotel Touraine, Boston, Mass.

CENTRAL RAILWAY CLUB OF BUFFALO.—Two speakers addressed the meeting held on November 10. James G. Lyne, assistant to the editor, Railway Age, discussed "The Present Political Situation as Related to the Railroads," and Harry L. Nancarrow, superintendent, Pennsylvania Railroad, discussed the "Railroads—Their Benefit to the City of Buffalo."

A. S. M. E. to Hold Annual Meeting December 5-9

THE American Society of Mechanical Engineers will hold its 59th annual meeting at the Engineering Societies building, New York City, on December 5-9. Delegates from 71 local sections of the society located in the United States and Canada will meet to discuss ways and means of increasing the usefulness of this organization of 15,000 engineers to the individual member and his community.

The Railroad Division of the society, one of the 17 divisions each of which covers a specialized field in mechanical engineering, will bring a group of four papers to the meeting as follows: Counterbalancing of Reciprocating Weights in Steam Locomotives, by A. I. Lipetz, chief consulting engineer, American Locomotive Company; Electric Locomotives, by B. S. Cain, assistant engineer in charge of design, locomotive division, General Electric Company; Motive Power Characteristics and Lightweight Equipment, by R. Eksergian, Edward G. Budd Manufacturing Company; Annual Report of Progress in Railway Mechanical Engineering, by E. G. Young, Research professor, railway mechanical engineering, University of Illinois.

The first two of these papers will be presented at the morning session on Thursday, December 8 and the latter two will be presented at the afternoon sessions of the same day. At 6:30 p. m. will be held the annual dinner of the Railroad Division.

Tuesday, December 6

Afternoon

POWER—FUELS

Report of Boiler Feedwater Studies Committee, by C. H. Fellows

ELASTICITY—APPLIED PROBLEMS AND MECHANICAL SPRINGS (I)

Stresses in Helical Compression Springs, Present Status of the Problem, by C. T. Edgerton
Analysis of Effect of Wire Curvature on Allowable Stresses in Helical Springs, by A. M. Wahl
A Method of Calculating Energy Losses During Impact, by C. Zaener and H. Feshbach

Evening

Honors Night

Wednesday, December 7

Morning

OIL AND GAS POWER

Five Years' Progress of Oil and Gas-Power, by H. E. Degler
The Vectorscope—A new instrument useful in the solution of problems pertinent to study and design of internal-combustion engines, by G. J. Dashefsky

METAL-FORMING PROCESSES

The Effect of the Speed of Stretching and the Rate of Loading upon the Yielding of Mild Steel, by E. A. Davis
Tension Devices in Rolling Strip, by Morris Stone
The Forces Required for Rolling Strip Under Tension, by A. Nadai

Afternoon

ELASTICITY—APPLIED PROBLEMS AND MECHANICAL SPRINGS (II)

Deflection of Helical Springs under Transverse Loadings, by W. E. Burdick, F. S. Chaplin and W. L. Sheppard
Strength of Metals, with Special Reference to Spring Materials, by D. J. McAdam, Jr., and R. W. Clyne
Research Report on Helical Springs, by C. T. Edgerton

LUBRICATION

Thin Oil Films, by Walter Claypoole
Wear in Lubrication Problems, by L. M. Tichvinsky

Evening

Annual banquet and President's reception, Astor Hotel

Thursday, December 8

Morning

RAILROAD

Counterbalancing of Reciprocating Weights in Steam Locomotives, by A. I. Lipetz
Electric Locomotives, by B. S. Cain

Afternoon

EDUCATION AND TRAINING

The Cost of Apprenticeship, by Warner Seely
Industrial Training in the Air-Conditioning Industry, by Ray D. Smith

RAILROAD

Motive-Power Characteristics and Lightweight Equipment, by R. Eksergian
Annual Report of Progress in Railway Mechanical Engineering, by E. G. Young

Evening

Railroad dinner

Chicago Car Men Elect Officers

AT the annual meeting of the Car Foremen's Association of Chicago, on Friday evening, October 7 at the LaSalle hotel, the following officers were elected for the ensuing year: president, P. B. Rogers, car shop superintendent, Atchison, Topeka & Santa Fe, Chicago; first vice-president, W. J. Healion, superintendent of shops, North American Car Corporation, Blue Island, Ill.; second vice-president, C. A. Erickson, general A. A. R. inspector, Chicago & North Western, Chicago; treasurer, C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago; secretary, G. K. Oliver, assistant passenger car foreman, Baltimore & Ohio Chicago Terminal, Chicago.

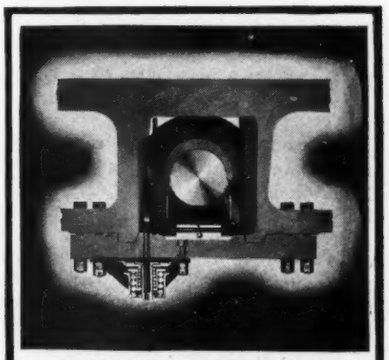
Retiring President F. A. Shoulty was elected to the board of directors which now comprises the following: Chairman, P. B. Rogers, Atchison, Topeka & Santa Fe.; F. A. Shoulty, Chicago, Milwaukee, St. Paul & Pacific; F. L. Kartheiser, Chicago, Burlington & Quincy; William Hartnett, Chicago & North Western; W. A. Emerson, Elgin, Joliet & Eastern; J. S. Acworth, General American Transportation Corporation; C. W. Broo, New York, Chicago & St. Louis; C. O. Young, Illinois Central; F. R. Callahan, Pullman Company; R. R. Hawk, Wilson Car Lines; A. E. Smith, Union Tank Car Corporation; K. A. Milar, Milar & Company; and W. J. Demmert, Griffin Wheel Company.

A. S. M. E. Elects 1939 Officers

THE American Society of Mechanical Engineers elected the following new officers for 1939, who will assume office on December 9: President—A. G. Christie, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md.; Vice-presidents—H. H. Snelling, Snelling & Hendricks, Washington, D. C.; W. L. Dudley, vice-president in charge of design and sales, Western Blower Company, Seattle, Wash.; A. Iddles, application engineer, Babcock & Wilcox Company, New York; James W. Parker, vice-president and chief engineer, Detroit Edison Company, Detroit, Mich.; Managers—C. Freeman, vice-president in charge of fire prevention engineering & underwriting, Manufacturers Mutual Fire Insurance Company, Providence, R. I.; William H. Winterrowd, vice-president, Franklin Railway Supply Company, Chicago, Ill., and W. R. Woolrich, dean of engineering, University of Texas, Austin, Tex.

(*Turn to next left-hand page*)

Differences in driving box temperatures of as much as 250° in short periods of time result in hand-adjusted driving box wedges being either too loose or too tight. » » » The solution is the Franklin Automatic Compensator and Snubber. With this application, accurate adjustment is constantly maintained . . . while the locomotive is running. » » » Any expansion or contraction that occurs in the driving box is automatically taken up. In addition, abnormal shocks are taken care of by a heavy outer spring that acts as a cushion. » » » For constant, accurate adjustment, easier riding, prevention of pounds, and reduced tire wear, incorporate Franklin Automatic Compensators and Snubbers.



Franklin Automatic Compensator and Snubber.

The close tolerances essential for efficient Booster operation call for genuine repair parts made by Franklin.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

NEWS

Soo Line Locomotives—A Correction

In the list of materials and equipment on the Minneapolis, St. Paul & Sault Ste. Marie locomotives on page 364 of the October issue of the *Railway Mechanical Engineer* it is incorrectly stated that the steam-heat regulator was furnished by the Vapor Car Heating Company. The regulator is of the Leslie type.

Side Frame Welding Rule Extended

The Board of Directors of the Association of American Railroads has extended to January 1, 1940, the effective date of revisions of Interchange Rule 3, Sec. t-3, Rule 19 and Rule 23, Sec. *II, III,* and *IV,* which revisions are contained in Supplement No. 2 to the 1938 Code of Interchange Rules, and are designed to prohibit the welding of L- and T-section cast steel side frames when such frames fail.

Former L. M. S. Mechanical Officer Dies

Sir Henry Fowler, who was chief mechanical engineer of the London, Midland & Scottish (Great Britain) between 1925 and 1930, died on October 16 at the age of 68. After an apprenticeship with the Lancashire & Yorkshire he entered the employ of the Midland in 1900 and became chief mechanical engineer in 1909. After the grouping of this company with the London, Midland & Scottish, Sir Henry became chief mechanical engineer of the L. M. S. in 1925. In 1930 he was appointed assistant to the vice-president for works.

P. R. R. Shopmen Reject A. F. of L. Unions

Shopmen on the Pennsylvania voted to reject seven craft unions of the American Federation of Labor and designated the Brotherhood of Railroad Shop Crafts of America, Pennsylvania System as their collective bargaining agent, according to an announcement by the National Mediation Board. The designated union, which is unaffiliated with either the A. F. of L., or the C. I. O., won by a vote of 17,003 to 10,934 when votes from 13 states and the District of Columbia were counted. The balloting also revealed that the accepted union had won the election in every craft.

Wages and Hours Law Effective October 24

Railroad employees generally came within the minimum-wage provisions of the wages and hours law when that act became effective on October 24. The carriers, along with other transport agencies subject to the Interstate Commerce Act, are exempt from the maximum-hours provisions. The minimum wage is fixed at 25 cents per hour for the first year of the law's operation; then it becomes 30 cents, and after six years, 40 cents.

It is not anticipated that the 25-cents minimum will affect any great proportion of railway employees. It is expected, however, that many questions of interpretation may arise before it is finally determined what railroad employees are involved; i. e. those actually engaged in interstate commerce. Like other industries the carriers are expected to have an industry committee to work in conjunction with Administrator Andrews, a matter which was before a recent meeting of the Association of American Railroads board of directors.

A. A. R. Tests Run at 102 M. P. H.

In the high-speed steam passenger locomotive tests with a 1,000-ton 16-car train, conducted by the Association of American Railroads over the lines of the Pennsylvania, the Chicago & North Western and the Union Pacific, speeds up to 102 m.p.h. were attained, and a large amount of information not heretofore available was secured regarding locomotive performance and train resistance in the upper-speed ranges. These tests were conducted for the A. A. R. Committee on Further Development of the Reciprocating Steam Locomotive, of which D. S. Ellis, chief mechanical officer, Chesapeake & Ohio, is chairman, details of the tests being under the direct supervision of W. I. Cantley, vice-chairman of the committee and mechanical engineer of the A. A. R. Mechanical division.

Test runs were made both east and westbound, on the lines of the Pennsylvania between Ft. Wayne, Ind., and Chicago; on the Chicago & North Western between Chicago and Omaha, Neb., and on the Union Pacific between Omaha, Neb., and Grand Island. On the Pennsylvania, two Class K-4-S locomotives of the 4-6-2 type, built about 1924, were used, these locomotives having 44,000-lb. rated tractive force, 205-lb. boiler pressure, and 80-in. driving wheels. On the westbound run, a maximum speed of 90 m.p.h. was reached and all necessary test data recorded. When the train reached a point about five miles west of Warsaw, Ind., and was proceeding at a speed of about 87 m.p.h., a part of the indicator drive mechanism on the right side of the locomotive broke and dropped into the valve motion, causing the union link to fail, with resultant blowing out of the cylinder heads, both front and back, on the right side. The train came to a stop without other damage to the locomotive or track and, after a slight delay, it proceeded with another locomotive to Chicago. On the eastbound run, made the latter part of the same week, this test train attained a maximum speed of 91 m.p.h., on a slightly descending grade without unusual incident.

The test runs on the Chicago & North Western were made with a new streamline Class E-4 locomotive of the 4-6-4 type, having 55,000-lb. rated tractive force, 300-lb. boiler pressure, and 84-in. driving wheels. The locomotive on the westbound trip, equipped with 12-in. piston valves, reached a maximum speed of 95 m.p.h. The locomotive on the eastbound trip, with 14-in. valves, attained a maximum speed of 89½ m.p.h., both of these speeds being made on slightly descending grades.

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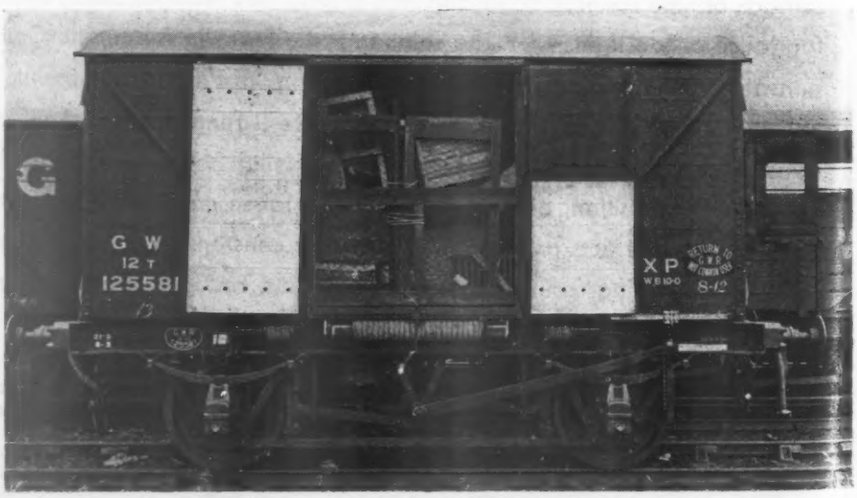
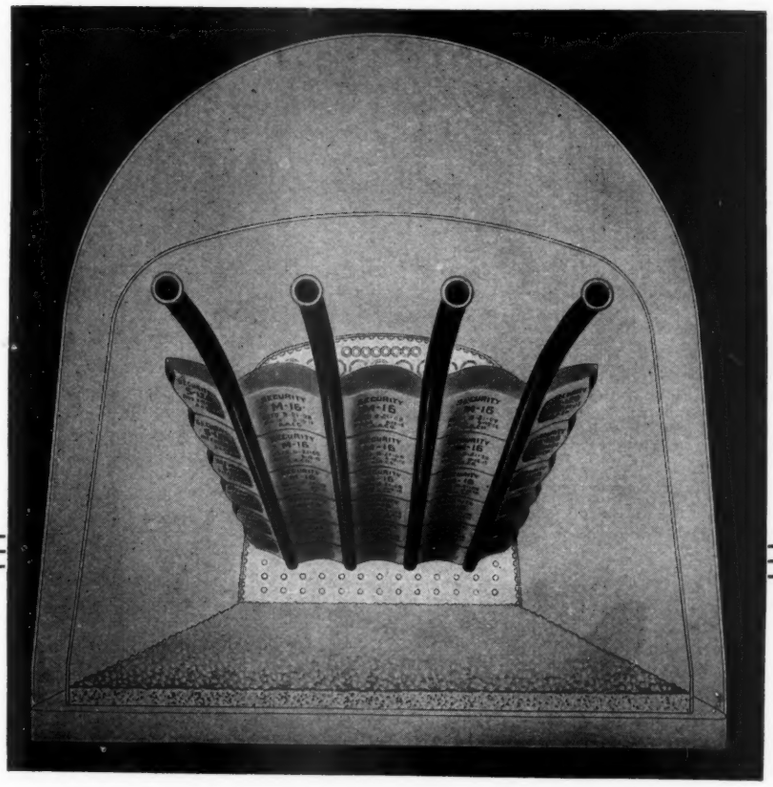


A 15-ton experimental shock-proof freight car of the Great Western of England
The car body is free to move longitudinally on the underframe under control of rubber springs. Switched against standing cars from speeds of 3.3 to 14 m.p.h., the body movement of the underframe varied from 1 in. to 13⅜ in. Loaded with fragile, unclaimed freight—toys, furniture, lamp shades, glassware—breakage in the trials was confined to five thin-glass lamp shades, three tumblers out of a carton, and one chair leg.



ANYTHING
less than a complete arch
IS FALSE ECONOMY

To let the desire for reduced inventory result in a locomotive leaving any roundhouse without a full set of Arch Brick is poor economy. » » » Even a single missing Arch Brick will soon waste many times its cost in fuel and in locomotive efficiency. » » » To spend the fuel dollar efficiently, every locomotive Arch must be maintained 100%. » » » Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency may be maintained.

There's More to SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists

AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

On the Union Pacific tests, a modern 4-8-4 type steam locomotive about one year old was used, having a rated tractive force of 63,000 lb., a boiler pressure of 300-lb., and 77-in. driving wheels. The maximum speed attained on the westbound trip to Grand Island was 89 m.p.h., and eastbound on a slightly descending grade 102 m.p.h.

The objective in these tests, conducted with a single train of 16 Pennsylvania cars having known scale weights, was not primarily to compare the three individual types of locomotives tested, but rather to secure actual data regarding general locomotive characteristics essential in meeting most satisfactorily the requirements of modern operating conditions. As soon as the test data are analyzed and studied a formal test report will be released for the information of individual railroads as well as the locomotive builders.

The research project of which these road tests are part was begun in 1937 by the Mechanical Division of the Association of American Railroads, which appointed a special committee to develop a reciprocating steam locomotive capable of handling 1,000 trailing tons at 100 miles per hour on level tangent track. To accomplish this, it was felt that from 5,000 to 5,500 cylinder horsepower would be required. At that time, the group agreed as to the general lines along which such a locomotive should be developed, with reference to the boiler pressure, the steam temperature, the factor of adhesion, etc.

Members of the Committee on Further Development of Reciprocating Steam Locomotive other than Messrs. Ellis and Cantley are W. R. Hedeman, assistant to chief motive power and equipment of the Baltimore & Ohio; J. E. Ennis, engineering assistant of the New York Central; W. R. Elsey, mechanical engineer of the Pennsylvania; J. M. Nicholson, acting mechanical superintendent of the Atchison, Topeka & Santa Fe; Lawford H. Fry, railway engineer of the Edgewater Steel Company; W. E. Woodard, vice-president of the Lima Locomotive Works; Harry Glaenzer, vice-president of the Baldwin Locomotive Works; J. B. Ennis, vice-president of the American Locomotive Company; E. G. Bailey, vice-president of the Babcock & Wilcox Company, and Edward C. Schmidt, professor of railway engineering at the University of Illinois.

C. P. Shopmen Agree to Three-Week Shutdown

UNION leaders, representing approximately 13,000 shop employees of the Canadian Pacific, and executives of the road recently agreed upon a three weeks' complete shut-down of the main shops of the system throughout Canada. The agreement, effective October 24, was reached after a closed conference between company officers and representatives of the Shop Crafts Federation of the Canadian Pacific, and was made in preference to a reduction of working forces. Shop employees agreed that a general shut-down and the resultant spread in loss of wage earnings would be more equitable than partial lay-offs.

Roosevelt Picks Reed for Retirement Board

ACCEPTING the recommendation of the Association of American Railroads, President Roosevelt, on October 1, appointed M. Roland Reed, formerly superintendent of motive power of the Pennsylvania's Eastern Pennsylvania division, as the carriers' representative on the Railroad Retirement Board for a five-year term. Mr. Reed succeeds James A. Dailey whose term expired on August 28. Mr. Reed was nominated by the A.A.R., while 137 members of the American Short Line Railroad Association endorsed Mr. Dailey for reappointment.

Mr. Reed was born July 26, 1883, in Newton, Ill., and was graduated from Rose

M. R. Reed

Polytechnic Institute in 1905 with a B.S. degree in mechanical engineering. Meanwhile he had entered railroad service during school vacations as a laborer in the Terre Haute (Ind.) shops of the Pittsburgh, Cincinnati & St. Louis (now P. R. R.). After graduation he returned to those shops to serve for a few months as a signal repairman before becoming a special apprentice in the Union Pacific shops at Omaha, Nebr. Mr. Reed returned to the P. C. & St. L.'s Terre Haute shops as a draftsman in September, 1906, serving in that capacity for one year, and thence for two years as assistant foreman. He was chief draftsman from 1909 to 1917, and general car inspector on the Pennsylvania's Northwest System during the next two years. From 1918 to July, 1926, Mr. Reed was successively superintendent of car repairs, master mechanic on the P. R. R. Eastern and Logansport divisions and assistant general superintendent of motive power for the Northwest region. During 1926-28 he was acting master mechanic and master mechanic on the Fort Wayne division, after which he became, successively, superintendent of motive power of the Northern and the Eastern Pennsylvania divisions and general superintendent of motive power for the Central region. He returned to the position of superintendent of motive power, Eastern Pennsylvania division, at Harrisburg in December, 1936.

R. F. C. Equipment Loans

The Southern is contemplating an R. F. C. loan of $6,000,000 to finance the purchase of 2,400 freight cars under arrangements similar to those whereby it acquired 5,704 freight cars earlier this year.

The Boston & Maine is negotiating for a loan of $2,000,000 to replace equipment damaged in the recent hurricane.

The Seaboard is seeking $725,000 for a Diesel-electric locomotive and 7 coaches.

New York Central.—The Interstate Commerce Commission, Division 4, has modified its report and certificate of August 19, so as to permit the New York Central to use the proceeds of the $5,000,000 loan originally intended for the repair of 1,000 freight-train cars, for the repair of approximately 50 additional locomotives. The commission has also ordered that the number of units given in the statement of the purposes for which the proceeds of the loan may be used should be considered approximately rather than exact.

Rail Unemployment Insurance Chief

THE Railroad Retirement Board, on October 1, announced the appointment of James Gordon Robinson as Director of Railroad Unemployment Insurance to ad-

(*Continued on next left-hand page*)

New Equipment Orders and Inquiries Announced Since the Closing of the October Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
New York Central	20*	600-hp. Diesel-elec. switch	Electro-Motive Corp.
	9*	600-hp. Diesel-elec. switch	American Loco. Co.
Pennsylvania	25†	21,000-gal. tenders	Company shops

LOCOMOTIVE INQUIRIES

Alaska	1‡	4-6-2	.....
St. Louis-San Francisco	5	4-8-2	.....

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Southern	20§	Express	Bethlehem Steel Co.

* Involve an expenditure of about $1,825,000, to be made in installments over a period of eight years.

† Approximate cost $550,000. For use with M-1 type freight locomotives.

‡ Inquiry renewed.

§ Subject to the approval of the I. C. C. as to the issuance and sale of securities to finance the cost.

NOTE: The Seaboard Air Line is making plans for the purchase of a new streamline train.

The Trend Is Towards Economical Injectors

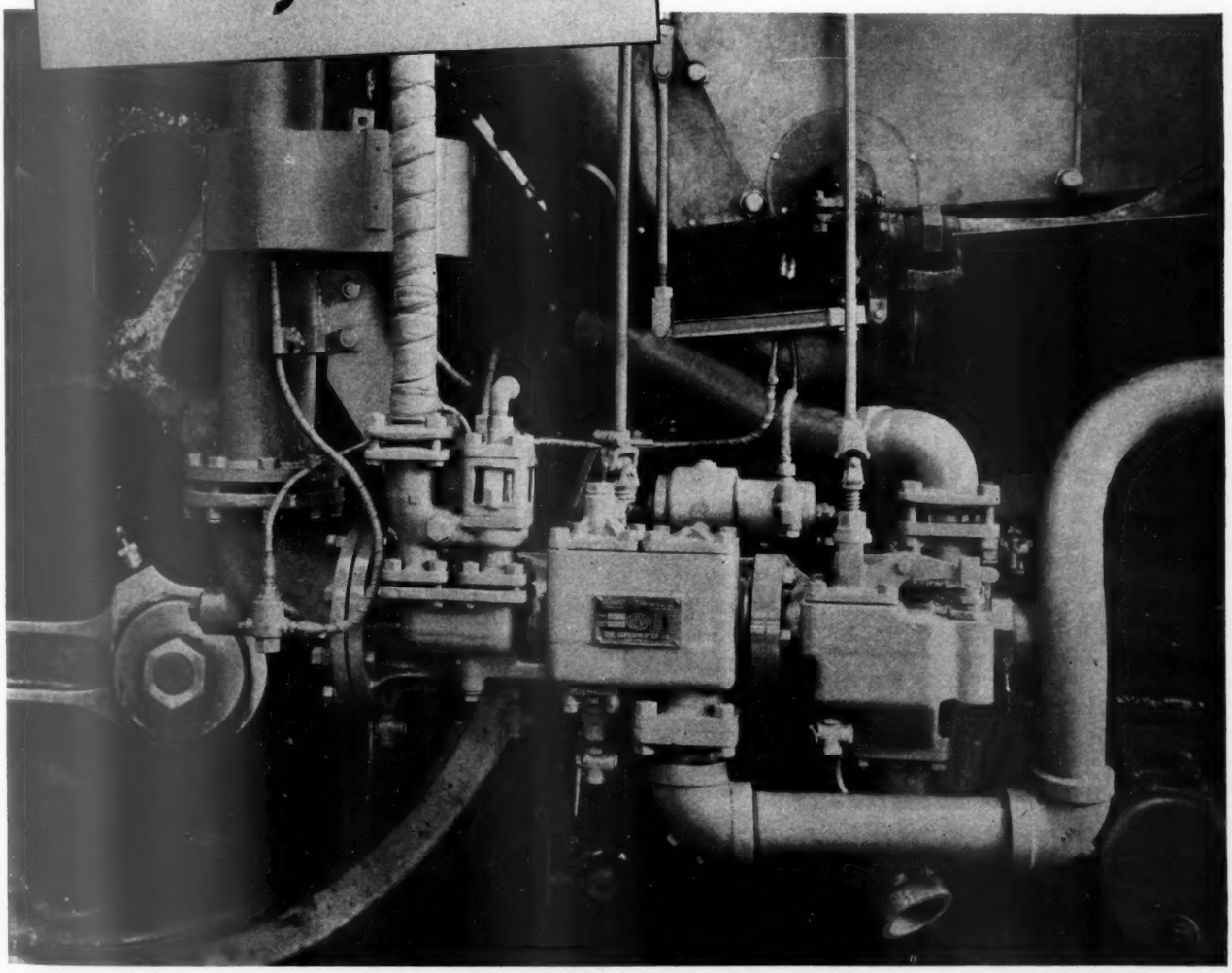
Elesco exhaust steam injectors use exhaust steam to both preheat and inject the feed water into the boiler.

The changeover from live steam to exhaust steam operation is entirely automatic.

Its operation is stable as the maximum amount of exhaust steam that can be condensed by the suction water is automatically admitted to the injector.

There are no constantly moving parts.

More than 20,000 injectors of this type have been applied to locomotives throughout the world.



ELESCO A-1272

THE SUPERHEATER COMPANY

Representative of AMERICAN THROTTLE COMPANY, INC.

60 East 42nd Street, NEW YORK 122 S. Michigan Ave., CHICAGO

Canada: THE SUPERHEATER COMPANY, LTD., MONTREAL

Superheaters « Exhaust Steam Injectors « Feed Water Heaters « American Throttles « Pyrometers « Steam Dryers

minister the new Railroad Unemployment Insurance Act which was passed at the last session of Congress. Mr. Robinson assumed his duties on October 3.

According to the Board's statement, Mr. Robinson has had a long career of experience as a consultant in private management and in public administration, as well as with the actual operation of unemployment insurance laws. His most recent experience in the latter field was as organizer and executive director of the Unemployment Compensation Commission of New Jersey. For about 15 years he has been associated with Griffenhagen & Associates, consultants in public administration and finance.

In an interview with the press after his induction into office, the new director said that his division, which will be a part of the Railroad Retirement Board, would employ about 1,000 persons from Civil Service rolls when the work gets into full swing. He expects to get the necessary machinery set up so that benefit payments can be paid after July 1, 1939. The director will receive claims for unemployment compensation prior to July 1, 1939, but no payments can be made until that date.

The Act, which Mr. Robinson will administer, creates a national pooled-fund system of unemployment insurance for railroad workers. As of July 1, 1939, it withdraws them from the coverage of Title IX of the Social Security Act and the state unemployment compensation acts. Contributions and benefits do not become payable until July 1, 1939. Contributions will be made by covered employers at the rate of three per cent of wages, excluding any amount in excess of $300 per month payable to any employee.

To become eligible for benefits an employee must (1) have earned $150, or more, from covered employment within the appropriate preceding calendar year and (2) have had, within six months preceding the beginning of a benefit year, a waiting period of fifteen consecutive days of unemployment, or two half months in each of which there were 8 days of unemployment.

Employees will be disqualified from the receipt of benefits for varying periods for such reasons as refusal to accept suitable work, voluntarily quitting work without good cause, discharge for misconduct, and other reasons.

Benefits, computed on a daily basis, will range from $1.75 to $3 per day in accordance with the amount earned during the base year. The maximum that an individual can receive during the benefit year is 80 times his daily benefit rate, the range thus being from $140 to $240.

Although the new law is founded on the same general philosophy as the unemployment insurance section of the Social Security Act, it is different in that the moneys collected from the railroads are to be "earmarked" for the Board's account and not placed in the Treasury's general fund as are the Social Security Board's funds. The Secretary of the Treasury may invest them, but he must not use them for paying other government bills.

Supply Trade Notes

W. I. HOWLAND, JR., vice-president in charge of western sales of the Carnegie-Illinois Steel Corporation, Chicago, has been transferred to Milwaukee, Wis., as manager of sales.

◆

JAMES A. BRADLEY & COMPANY, Chicago, have been appointed distributors for Youngstown Sheet & Tube Company's tubular products.

◆

STANLEY H. SMITH has been appointed railroad representative of the Gould Storage Battery Corporation in the Cleveland (Ohio) district, with headquarters at Cleveland.

◆

THE SILENT HOIST WINCH & CRANE CO., has moved its works and general offices from 762 Henry street to improved facilities at 841 to 865 63rd street, Brooklyn, N. Y.

◆

JOHN R. JOHNSTON, manager of sales of the Milwaukee district of the Carnegie-Illinois Steel Corporation, has been appointed assistant manager of sales of the Chicago district.

◆

WILLIAM SELLERS & CO., INC., Philadelphia, Pa., manufacturers, since 1848, of machine tools, has engaged Clarke-Harrison, Inc., management engineers, to take charge of all the company's operations, including research, design, engineering, manufacturing and sales.

◆

YALE D. HILLS has been appointed manager of distributor sales for the Service-sales Division of The Timken Roller Bearing Company. Mr. Hills' headquarters are at the main Timken factory at Canton, Ohio. For several years he has been manager of the Los Angeles, Cal., territory branch of the company.

◆

JOHN A. MACLEAN, JR., assistant to the president of the MacLean-Fogg Lock Nut Company, Chicago, has been elected president, to succeed John A. MacLean, deceased. Mr. MacLean, Jr., was born at Wilmette, Ill., on January 22, 1905, and

John A. MacLean, Jr.

graduated in civil and mechanical engineering from Sheffield Scientific School, Yale University, in 1927. The following year he went with the MacLean-Fogg Lock Nut Company as assistant to the president.

◆

FACILITIES of the USL Battery Corporation in Niagara Falls, N. Y., formerly devoted to the manufacture of batteries for railroad, industrial and utility service are now being utilized for automobile battery manufacture, and the company's industrial battery division is being discontinued. Arrangements have been made with the Gould Storage Battery Corporation, Depew, N. Y., to acquire the USL power battery department and to continue for USL customers complete inspection and replacement service covering USL industrial batteries now in the field.

◆

JAMES A. KING, vice-president in charge of production of the Morton Manufacturing Company, Chicago, has been relieved of his duties pertaining to factory operations and will hereafter devote his full attention and time to engineering and sales promotion including his personal supervision of sales to steam and electric railways and the bus industry in the central United States district.

Obituary

G. LA RUE MASTERS, vice-president of the National Lock Washer Company, Newark, N. J., died on October 25, at his home in South Orange, at the age of 58 years.

◆

J. DONALD CUNNINGHAM, a sales engineer of the Southern Wheel Division of The American Brake Shoe and Foundry Co., died at his home in Cleveland, Ohio, on October 7, after a short illness.

◆

JOHN F. O'CONNOR, who retired as consulting engineer of W. H. Miner, Inc., Chicago, in 1930, died on September 28 of a complication of ailments. He was born in Ireland in 1864, and started work at the age of 15 as a machinist's helper for the New York, New Haven & Hartford. After holding the positions of machinist, and locomotive inspector, he became general

foreman of the enginehouse and shops at Providence, R. I., from which position he resigned to enter the employ of the Sterlingworth Railway Supply Company. Five years later, in 1904, he resigned to become mechanical engineer for W. H. Miner, Inc., and later was appointed consulting engineer. Mr. O'Connor had obtained approximately 1,000 patents, most of which covered draft gears and parts. Other patents covered snow plows, wrecking equipment and shop devices. One of the most important of these is a chronometer for measuring with extreme accuracy the reaction developed upon impact of two bodies at high speed, a device that has been of great help in measuring the stress to which draft gears are subjected.

Personal Mention

General

L. L. WHITE has been appointed vice-president of the Erie, with headquarters at Cleveland, Ohio, having supervision over purchases and development.

L. H. SCHEIFELE, tool and material inspector of the Reading, with headquarters at Reading, Pa., has been appointed engineer of tests, with the same headquarters, succeeding J. B. Young, deceased.

C. B. HITCH, assistant superintendent motive power of the Chesapeake & Ohio, with headquarters at Huntington, W. Va., has been appointed superintendent motive power at Richmond, Va., succeeding T. F. Barton, deceased.

E. D. HALL, chief chemist of the Erie, with headquarters at Meadville, Pa., has been appointed engineer of tests and chief chemist. C. P. BROOKS has been appointed assistant engineer of tests of the Erie with headquarters at Meadville, Pa.

F. A. BUTLER, superintendent motive power and rolling stock of the Boston & Albany, who retired on September 30 as announced in the October issue of the *Railway Mechanical Engineer*, was born on September 21, 1868, at Shrewsbury, Mass., and entered railway service on June 20, 1892, with the Boston & Albany as a locomotive fireman. He then became engineman and later worked in the enginehouse at Beacon Park, Allston, Mass. In May, 1908, he was appointed road foreman of engines and in July, 1910, became master mechanic of the Boston division. Mr. Butler was transferred in the latter capacity to the Albany division in November, 1916, and in January, 1924, was appointed superintendent motive power and rolling stock at Boston. The position of superintendent of motive power and rolling stock has been abolished.

F. A. Butler

THOMAS W. DEMAREST, general superintendent motive power of the Pennsylvania, at Philadelphia, Pa., who retired on September 1, was born on March 18, 1868, at Englewood, N. J., and was graduated from the Stevens Institute of Technology, Hoboken, N. J. He entered the service of the Pittsburgh, Cincinnati & St. Louis (P. R. R.) on August 1, 1889, as a special apprentice at Columbus, Ohio. From August, 1891, to February, 1896, he was assistant to superintendent motive power of the same road at Columbus, and from the latter date until February, 1897, was assistant to master mechanic at Indianapolis, Ind. Mr. Demarest served as general foreman locomotive department at Indianapolis from February, 1897, to August, 1899; master mechanic at Logansport, Ind., from August, 1899, to January, 1900; superintendent motive power from January, 1900, to July, 1903, all with the Pittsburgh, Cincinnati & St. Louis and its successor, the Pittsburgh, Cincinnati, Chicago & St. Louis (now Pennsylvania). He was superintendent motive power Northwest system, Pennsylvania Lines West of Pittsburgh, at Ft. Wayne, Ind., from July, 1903, until March, 1920, and from the latter date until June, 1925, served as general superintendent motive power, Northwestern region, Pennsylvania system, at Chicago. Mr. Demarest became general superintendent motive power of the Western region at Chicago in June, 1925, and general superintendent motive power of the Pennsylvania at Philadelphia in December, 1936. Mr. Demarest has a long record of distinguished service in various capacities with the A.A.R. Mechanical division and its predecessor, the Master Car Builders' Association, which he joined in 1900, becoming a vice-president in 1915. He was made a member of the Arbitration Committee in 1901 and served as chairman from 1924 to 1935, then relinquishing the chairmanship, but continuing on the committee until 1937.

T. W. Demarest

N. M. TRAPNELL, assistant to superintendent motive power of the Chesapeake & Ohio, at Richmond, Va., has been appointed assistant superintendent motive power with headquarters at Richmond, succeeding C. B. Hitch. The position of assistant to superintendent motive power has been abolished. A photograph of Mr. Trapnell and a biographical sketch of his railway career were published in the September issue of the *Railway Mechanical Engineer*.

Master Mechanics and Road Foremen

J. SHELABERGER, master mechanic of the Southern Pacific at West Oakland, Calif., retired on October 1.

A. C. SCHOEDINGER, assistant master mechanic of the Louisville & Nashville at Boyles, Ala., retired on September 1.

S. M. HOUSTON, assistant master mechanic of the Southern Pacific at West Oakland, Cal., has been promoted to master mechanic, succeeding J. SHELABERGER.

F. J. CARTY, mechanical engineer of the Boston & Albany, with headquarters at Boston, Mass., has been appointed master mechanic with the same headquarters.

CHAS. J. DIETRICH, who has been appointed master mechanic of the Galesburg-Ottumwa division of the Chicago, Burlington & Quincy at Galesburg, Ill., as announced in the October issue, was born on March 16, 1892, at Lincoln, Nebr. He received a high-school education and from 1910 until 1914 was a machinist apprentice in the employ of the C. B. & Q., first at Lincoln, and a year later at Havelock, Nebr. From 1914 until 1922 he was engaged in outside business. Returning to the Burlington he became lead machinist at Lincoln on October 25, 1922; enginehouse foreman at Casper, Wyo., on November 27, 1925; general foreman at Wymore, Nebr., on June 1, 1926; general foreman at Alliance, Nebr., on September 1, 1928; day enginehouse foreman at Alliance on November 5, 1931; general foreman at Lincoln on August 1, 1935; master mechanic at McCook, Nebr., on May 16,

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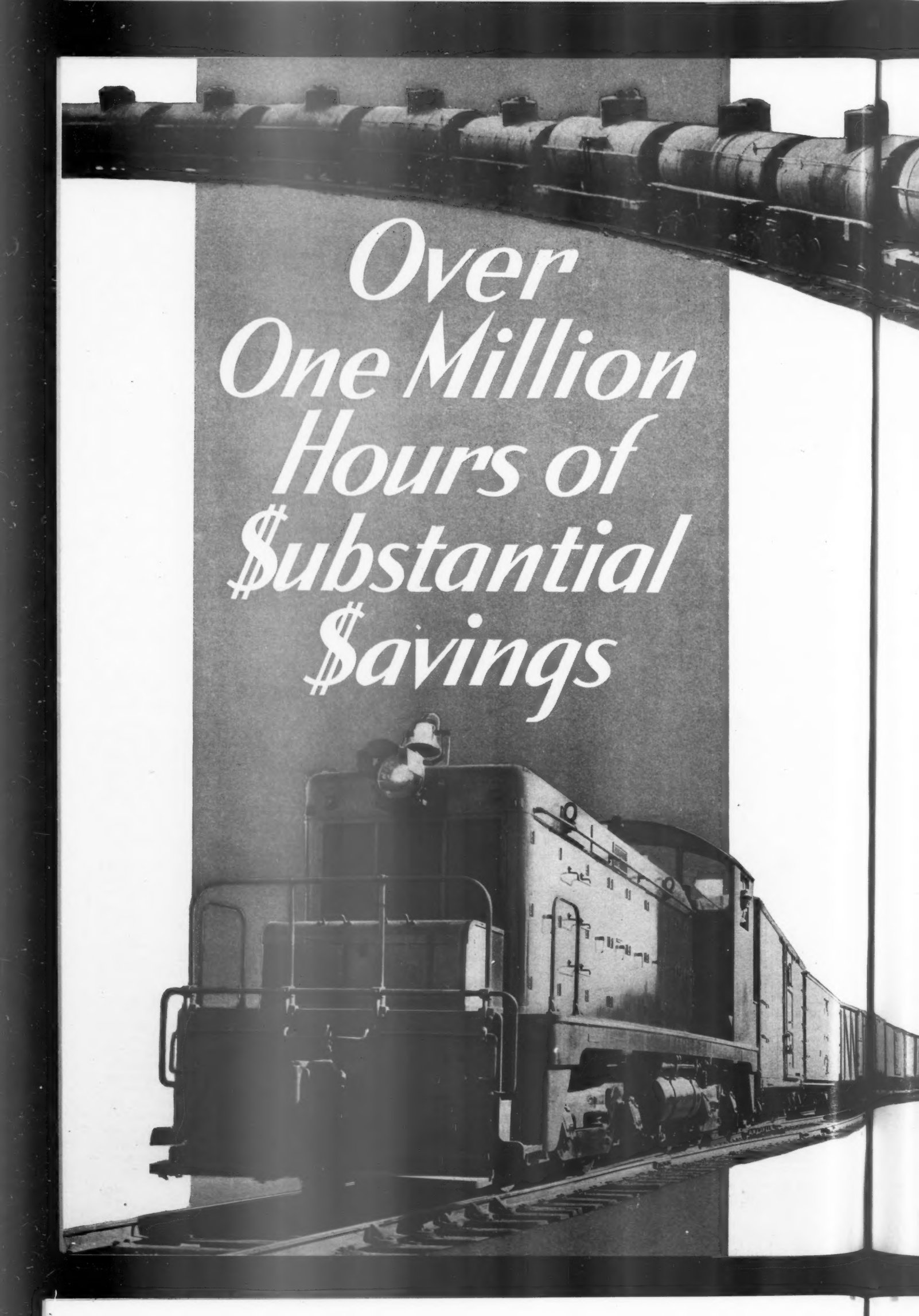
Over
One Million
Hours of
$ubstantial
$avings

NO other type of motive power has so convincingly demonstrated its capability of effecting substantial savings in operating costs as EMC Diesel Switchers.

With over ONE MILLION hours of service to date, EMC 600 Hp. and 900 Hp. Diesel switchers are operating with an average hourly fuel consumption of 4.8 and 7.2 gallons per hour respectively, which is equivalent to an 80 per cent reduction in fuel expense.

But EMC Diesel economies go far beyond fuel savings. Maintenance costs have been cut in half — enginehouse expenses reduced to a third and water costs to practically nothing. And for SERVICEABILITY — the 600 Hp. and 900 Hp. EMC Diesels are averaging 94 per cent availability with some records as high as 98 per cent.

ELECTRO-MOTIVE CORPORATION
SUBSIDIARY OF GENERAL MOTORS LA GRANGE, ILLINOIS, U. S. A.

1936; master mechanic at Alliance on March 1, 1937, and master mechanic at Galesburg on September 16, 1938.

Car Department

B. H. BARRETT, general car inspector on the Chicago, Burlington & Quincy, with headquarters at Lincoln, Neb., has been promoted to superintendent of shops at Havelock, Neb., succeeding J. D. Rezner.

J. D. REZNER, superintendent of shops of the Chicago, Burlington & Quincy at Havelock, Neb., has been appointed general car foreman, with headquarters at Chicago.

H. H. HARVEY, general car foreman of the Chicago, Burlington & Quincy at Chicago, retired on November 1.

WILLIAM P. SHOTWELL has been appointed supervisor of air-conditioning and lighting of the Erie with headquarters at Susquehanna, Pa. Mr. Shotwell, who will report to the superintendent of the car department at Cleveland, Ohio, will be responsible for the proper functioning and maintenance of air-conditioning equipment and car lighting and also for the overhauling of this equipment while cars are going through the shop.

Shop and Enginehouse

I. N. MOSELEY, who has been appointed master boilermaker of the Norfolk & Western system, with headquarters at Roanoke, Va., as noted in the October issue, was born at Vinton, Va., on November 13, 1894, and entered the service of the Norfolk & Western as a draftsman in the mechanical engineer's office. He was promoted to the position of mechanical inspector on May 1, 1924, and on July 2, 1925, became general foreman of the foundry department at Roanoke shops. Mr. Moseley succeeds John A. Doanberger, retired.

I. N. Moseley

JOHN A. DOANBERGER, who has retired as master boilermaker of the Norfolk & Western as noted in the October issue, was born in Hagerstown, Md., on August 6, 1867. He began his career as a boilermaker apprentice on April 1, 1883, in the employ of the Hagerstown Steam Engine and Machine Company. On September 24, 1886, he went to Roanoke as a boilermaker at the machine works of the Norfolk & Western. He became assistant foreman of the boiler shop on April 1, 1889, and foreman on July 1, 1893. He resigned on September 21, 1897, to become superintendent of the boiler department of the American Locomotive Company at Richmond, Va. After three years' service with the American Locomotive Company and the Lake Shore & Michigan Southern at Cleveland, Ohio, Mr. Doanberger returned to the Norfolk & Western as boiler shop foreman, and on December 16, 1907, was appointed master boilermaker for the system.

J. A. Doanberger

Obituary

J. BERTRAM YOUNG, engineer of tests of the Reading since 1920, died on July 29.

C. E. BURCHFIELD, superintendent of the Knoxville division of the Southern, with headquarters at Knoxville, Tenn., died on October 5.

OSCAR G. MCPHAIL, fuel supervisor on the Louisville & Nashville, with headquarters at Louisville, Ky., died on September 25.

WERNER C. GROENING, retired chief air-brake inspector of the Chesapeake & Ohio at Grand Rapids, Mich., died on August 18 at the age of 76. Mr. Groening had served as a machinist, erecting foreman, general foreman, superintendent of shops, inspector of equipment and road foreman of engines before being promoted to the position of chief air-brake inspector in 1918.

G. E. COUTANT, chief draftsman of the Wabash passed away October 13. Mr. Coutant entered railroad service as a car repairer for the Wabash, St. Louis & Pacific, at Butler, Ind., in 1888. Later Mr. Coutant was employed by the Louisville & Nashville at Louisville, and in 1892 entered the service of the Wabash at Springfield, Ill., as a draftsman, where he remained until 1911, when he went with the Ann Arbor as master mechanic. In 1914 Mr. Coutant re-entered the employ of the Wabash at Springfield, Ill., as general inspector, was transferred to Decatur, Ill., in 1915, and made assistant to superintendent motive power in 1917. In 1932, in addition to his other duties, he assumed charge of the drafting room, with the title of chief draftsman.

JOHN WILLIAM SASSER, consulting superintendent motive power of the Virginian, with headquarters at Norfolk, Va., died at his home near Raleigh, N. C., on October 16, at the age of 61. Mr. Sasser had been superintendent motive power from January 1, 1921, until June 1, 1938, when, due to ill health, he was appointed consulting superintendent motive power. A detailed sketch of Mr. Sasser's railroad career was published in the July, 1938 issue of the *Railway Mechanical Engineer*.

C. A. ZWEIBEL, general foreman of the car department at the South Louisville shops of the Louisville and Nashville, died October 14. After serving in various capacities with the Atlantic Coast Lines and the Central of New Jersey, Mr. Zweibel went to work for the Louisville & Nashville as general foreman of the car department at Boyles, Ala., on September 15, 1919, being transferred in a similar capacity to the South Louisville shops on October 1, 1927.

GEORGE W. SMITH, former superintendent of motive power of the Chicago & Eastern Illinois, and retired superintendent of machinery of the Missouri Pacific, died on October 14 at his home in Evanston, Ill. Mr. Smith was born at Rochester, N. Y., on February 29, 1856, and entered railway service in 1870 as an engine-wiper on the Chicago and Iowa (later a part of the Chicago, Burlington and Quincy), at Aurora, Ill. He later became a fireman on the Michigan Central at Joliet, Ill., and a machinist apprentice for the same road at Jackson, Mich. In 1877, he returned to the Chicago and Iowa as a machinist at Aurora, and in 1878, became associated with the Atchison, Topeka and Santa Fe as a machinist at Topeka, Kan. He subsequently served the Santa Fe as enginehouse foreman at Argentine, Kan., and master mechanic at Nickerson, Kan.; Topeka, Kan., and Albuquerque, N. M. Mr. Smith left the Santa Fe in the summer of 1902 to become master mechanic of the Illinois Central, with headquarters at Waterloo, Iowa. The following spring he was appointed assistant superintendent of machinery with headquarters at Chicago. In the spring of 1904, he left the Illinois Central to go with the Chicago and Eastern Illinois as superintendent of motive power, with headquarters at Danville, Ill. A year later he became superintendent of machinery of the Missouri Pacific, with headquarters at St. Louis, Mo., from which position he retired in June, 1911.

JOHN HENNESSEY, retired master car builder of the Chicago, Milwaukee, St. Paul & Pacific, died at Milwaukee, Wis., on September 27. Mr. Hennessey was born in Waukesha County, Wis., in 1847, and entered railway service in July, 1871, in the Milwaukee shops at Prairie du Chien, Wis. He was later transferred to the shops at Milwaukee and Chicago. In 1879 he was

(*Continued on next left-hand page*)

NATIONAL A.A.R. APPROVED DRAFT GEARS

NATIONAL M-17-A DRAFT GEAR
22⅜" long
A.A.R. Approved

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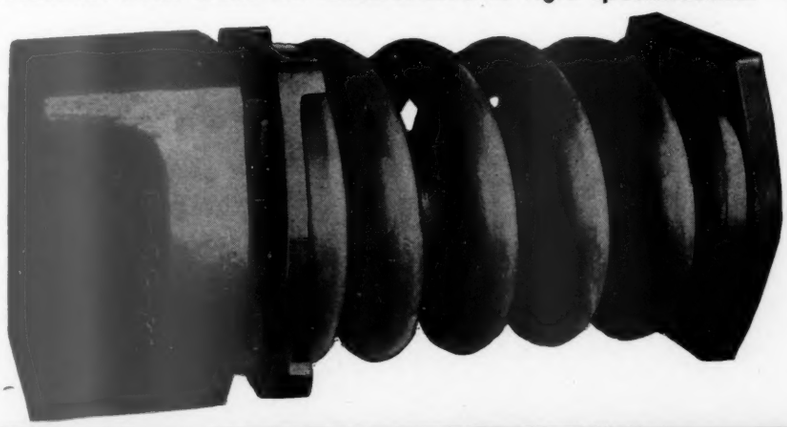
The friction segments act inwardly against the sturdy friction member, with the result that this important member that must absorb all service reactions is subject to compressive stresses.

The M-17-A and M-50-B draft gears are basically of the same design and are adapted for service in cars having A.A.R. standard size draft gear pockets. The M-17-A draft gear is 22⅜ inches long and requires one standard follower. The M-50-B draft gear is 20⅛ inches long and requires two standard followers. This gear also may be used in cars having certain non-standard draft gear pockets.

National Draft Gears are manufactured to rigid specifications. All functional parts are accurately heat treated to withstand the most severe service. When you use these gears in your cars you are assured of highly dependable service at low cost.



NATIONAL M-50-B DRAFT GEAR
20⅛" long
A.A.R. Approved

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General Offices: CLEVELAND, OHIO
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promoted to foreman at the Milwaukee shops, and in 1880 he was appointed inspector of new car construction at the various contract shops where the Milwaukee was having passenger and freight cars built. In 1887 he was advanced to general foreman of the West Milwaukee

John Hennessey

car department shops, and in 1888 was promoted to master car builder, with headquarters at Milwaukee, the position he held until his retirement in February, 1918. Mr. Hennessey initiated many improvements in car construction, some of which he patented, notably the steel center sills in conjunction with continuous steel body bolster, door fixtures, rocker frictionless side bearing, and a friction draft gear, which was one of the first gears of the friction type. He was especially active in the Mechanical division of the Association of American Railroads and its predecessor, the Master Car Builders' Association, of which he was president in 1902. He served on various important committees notably the Executive and Arbitration committees, having a record of 35 years' continuous membership on the latter, including 17 years as chairman.

FRED P. PFAHLER, who resigned in 1930 as assistant to chief of motive power and equipment of the Seaboard Air Line at Savannah to accept a position as service agent with the Interstate Commerce Commission at Washington, D. C., died on October 14. Mr. Pfahler was born at Sunbury, Pa., on June 21, 1875, and entered the service of the Pennsylvania as yard clerk on the Sunbury division in November, 1889, going with the Baltimore & Ohio in March, 1899, as fireman on the Connellsville division and machinist at Pittsburgh, Pa. In October, 1904 Mr. Pfahler became enginehouse foreman of the Erie at Buffalo, N. Y., and in January, 1905, returned to the B. & O. as machine shop foreman at Willard, Ohio. From May to September, 1905, he was general foreman on the Seaboard Air Line at Hamlet, N. C.; then serving until April, 1906, as draftsman on the Baltimore & Ohio at Baltimore, Md. From April, 1906, to October, 1911, he was mechanical engineer of the Wheeling & Lake Erie at Norwalk, Ohio, returning to the B. & O. in March, 1916, and serving successively as general mechanical inspector at Baltimore, master mechanic of the Pittsburgh and Cumberland divisions, supervisor locomotive maintenance at Baltimore and district master mechanic at Pittsburgh, Pa. He was assistant to chief of motive power and equipment of the Seaboard Air Line from October 1, 1925, to April, 1930.

T. F. BARTON, superintendent motive power of the Chesapeake & Ohio, with headquarters at Richmond, Va., died on October 14. Mr. Barton was born in London, England, on March 21, 1867, and began his railroad career in 1887 with the Grand Trunk. He remained in the employ of that road for six years, serving successively as machinist apprentice, locomotive fireman and journeyman. During the 10 years he served with the Illinois

T. F. Barton

Central he held the positions of machinist, gang foreman, enginehouse foreman, general foreman, master mechanic and superintendent of shops. Prior to his connection with the Chesapeake & Ohio he was in the employ of the Delaware, Lackawanna & Western for a period of 15 years, serving in the capacity of master mechanic at Kingsland, N. J., when he accepted the position of master mechanic of the C. & O. He was appointed general master mechanic of the Western General division at Huntington, W. Va., on February 1, 1924, which position he held until May, 1930, when he was promoted to superintendent motive power at Richmond.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

SPRAY EQUIPMENT.—Eclipse Air Brush Co., Inc., Newark, N. J. 32-page booklet, illustrated. Points out savings and advantages of Eclipse spray equipment under practical working conditions. Test data.

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TANTALUM CARBIDE TOOLS AND BLANKS. Vascoloy-Ramet Corporation, North Chicago, Ill. Twelve-page catalog and price list of Vascoloy-Ramet standard tantalum carbide tools and blanks.

◆

CHECK VALVES.—Crane Co., 836 South Michigan avenue, Chicago. 8-page booklet, "Checking up on Check Valves." Describes two basic types of check valves and their various applications.

◆

FOOT INJURIES. — Lehigh Safety Shoe Co., Allentown, Pa. "A Handbook of Facts for the Safety Engineer." Devoted to a showing of Lehigh safety shoes and informative material on general industrial safety, including several factory-tested suggestions on how industrial injury frequency rates can be reduced.

FORGING PRESSES.—The Ajax Manufacturing Company, Euclid Branch P. O., Cleveland, Ohio. Bulletin No. 75; 16 pages. Describes and illustrates Ajax solid frame forging presses, with air-operated clutch, for accurate hot forging and precision hot and cold coining. Press sizes 500 to 2,000 tons.

◆

U. S. S. HIGH-TENSILE STEELS.—Carnegie-Illinois Steel Corporation, 434 Fifth avenue, Pittsburgh, Pa. Eight-page illustrated booklet. Technical and general information concerning applications, advantages and fabrication of U. S. S. high-tensile steels—Cor-Ten, Man-Ten and Sil-Ten. Charts of chemical compositions, physical properties and miscellaneous information.

VALVES, BOILER MOUNTINGS, ETC.—The Lunkenheimer Co., Cincinnati, Ohio. 44-page List Price Schedule covering entire line of valves, boiler mountings, and lubricating devices. Listed numerically by figure number.

◆

WELDING ALUMINUM.—Aluminum Company of America, Pittsburgh, Pa. Revised 48-page, illustrated booklet on Welding aluminum and its alloys. Sections on fusion welding, welded aluminum vessels, torch welding heat-treated aluminum alloys, welding castings, arc welding, and resistance welding.

◆

REPLICAS OF LOCOMOTIVES. — Simmons-Boardman Publishing Corporation, Book Service Department, 30 Church street, New York. A four-page bulletin, "Exact Replicas of Great Locomotives," illustrating heavy silver-plated replicas, with an oxidized finish, for use as paperweights, (mounted on a padded metal base shaped like a railway roadbed) or as pen and pencil trays (mounted on onyx). Prices given.